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CHRONOLOGY OF 'SALYUT-7' FLIGHT

[Editorial Report] The Soviet News Agency TASS reports the following information on activities connected with the flight of the "Salyut-7" space station.

17 Oct

Yesterday by command from the Flight Control Center the "Progress-15" craft was oriented in space. At 2008 hours Moscow time its engine was turned on. The ship entered a descent trajectory, re-entered the dense layers of the atmosphere over the Pacific Ocean and ceased to exist. Cosmonauts Berezovoy and Lebedev have now been in space for 157 days. Yesterday was a day of rest. The cosmonauts observed the earth, exercised and met with their families in a two-way television communication. Today they will carry out a scheduled cycle of geophysical experiments and perform a number of preventive maintenance operations on the station. (Moscow PRAVDA in Russian 18 Oct 82 p 1)

19 Oct

Yesterday was devoted primarily to astrophysical research to study the interplanetary environment and galactic and extra-galactic radiation sources. Four photographic sessions were performed using the Piramig apparatus developed in France. Subjects of the observations were the constellations Sagittarius, Orion, Taurus and Auriga. Today's schedule includes visual observation and photography of land and water areas. Later in the day the cosmonauts will study the earth's atmosphere with the aid of spectro- and photometric apparatus. (Moscow PRAVDA in Russian 20 Oct 82 p 1)

22 Oct

Cosmonauts Berezovoy and Lebedev have completed their 23rd week aboard "Salyut-7". As part of the regular schedule of medical examinations, today they will perform measurement of body mass, evaluation of muscle condition and determination of the reaction of the cardiovascular system to simulated hydrostatic pressure. Cardiac activity is studied using the "Chibis" vacuum suit in which a drop in barometric pressure causes a flow of blood to the lower part of the body, thus simulating earth's gravity. Physiological parameters are recorded by the "Aelita-01" and "Reograf" apparatus. Today's

schedule also includes determination of characteristics of the atmosphere surrounding the station and physical exercise. Tomorrow the cosmonauts will have a day of rest. (Moscow IZVESTIYA in Russian 23 Oct 82 p 1)

26 Oct

The cosmonauts have been aboard "Salyut-7" for 165 days. A large part of their work has been devoted to observation and photography of land and ocean areas in the program of earth resources studies. In order to determine the effect of the atmosphere on these studies the cosmonauts will perform research to evaluate the spectral and optical characteristics of the atmosphere. The latest cycle of research with "Piramig" apparatus has been completed. Observations were made of the constellations Andromeda, Cassiopeia, Cetus and Pegasus. Yesterday the crew tested navigation equipment as part of the program to develop equipment and apparatus for future spacecraft. (Moscow IZVESTIYA in Russian 27 Oct 82 p 1)

29 Oct

The cosmonauts have begun their 25th week in orbit. Today the crew has a medical day. Studies are scheduled on reaction of the circulatory system to measured physical loads, evaluation of the cardiovascular system with the "Ekhograf" apparatus and a number of biomedical studies. Experiments are also continuing on the station to achieve an in-depth study of the development of various biological objects in spaceflight conditions and to improve systems for plant cultivation. At the present time the subjetts of the latter studies are onion, parsley, radish and borage. Tomorrow the cosmonauts will have a day of rest. They will clean up the station quarters, exercise and meet with their families. (Moscow PRAVDA in Russian 30 Oct 82 p 1)

31 Oct

At 1420 hours Moscow time on 31 October the "Progress-16" automatic cargo ship was launched in the Soviet Union. The ship will deliver expendables and various other cargo to the "Salyut-7" station. "Progress-16" was inserted into an orbit with the following parameters: apogee, 263 km; perigee, 193 km; period of revolution, 88.7 minutes; inclination, 51.6 degrees. According to telemetry data, all on-board systems of the automatic cargo ship are operating normally. (Moscow PRAVDA in Russian 1 Nov 82 p 1)

2 Nov

At 1622 hours Moscow time on 2 November the "Progress-16" cargo ship docked with the "Salyut-7"--"Soyuz T-7" complex. Mutual search, rendezvous and docking were carried out on commands from the Flight Control Center and with the aid of on-board automatic equipment. The docking process was monitored by cosmonauts Berezovoy and Lebedev. "Progress-16" docked at the service module of the station. According to telemetry and reports from the crew, all systems are functioning normally. (Moscow PRAVDA in Russian 3 Nov 82 p 3)

5 Nov

Cosmonauts Berezovoy and Lebedev are completing their 176th day in orbit. Recent days have been primarily devoted to unloading the "Progress-16" craft. Most of the cargo has already been transferred to the station. Today's schedule includes astrophysical experiments, tests of navigation equipment and physical exercises. A cycle of biotechnical experiments has been started in the "Tavriya" unit. The goal is to develop improved methods and apparatus for obtaining highly pure biologically active substances in weightlessness. The crew's schedule for tomorrow includes visual observations of the earth's surface and a shower. On 7 November a television report will be transmitted to the station showing celebrations in Red Square marking the 65th anniversary of the October Revolution. (Moscow PRAVDA in Russian 6 Nov 82 p 3)

9 Nov

Cosmonauts Berezovoy and Lebedev have been in orbit for 180 days. The cosmonauts rested on 7 and 8 November; today they resume the planned work schedule. In the morning an experiment was begun in the "Tavriya" unit to study processes of electrophoresis. The experiments are being performed in an improved apparatus which incorporates results from the work performed earlier by the visiting crew of cosmonauts Popov, Serebrov and Savitskaya. Today the crew will also carry out a number of maintenance operations, tend the plants and exercise. Tomorrow they will perform medical studies, including a check of the cardiovascular system under physical load. (Moscow PRAVDA in Russian 10 Nov 82 p 10

12 Nov

Today the cosmonauts are performing experiments with the "Piramig" and "PCN" apparatus. Before starting, the cosmonauts calibrate the equipment according to the sun. Photography is performed in the shadow section of the orbit. The experiments are designed to study earth's atmosphere, interplanetary space and galactic and extra-galactic sources of radiation. Yesterday the crew checked the operation of individual on-board systems of the station and the transport ship and performed a number of medical and biological studies. (Moscow PRAVDA in Russian 13 Nov 82 p 6)

16 Nov

The flight of cosmonauts Berezovoy and Lebedev, now the longest in the history of cosmonautics, is continuing. The schedule for the 188th day includes earth resources studies, testing of navigation methods and equipment, servicing of on-board systems of "Salyut-7" and physical exercises. A "Refraction" experiment is being performed to solve questions in meteorology and atmospheric optics. The rising and setting sun is photographed at various heights above the horizon. Distortions of the image caused by light refraction in the atmosphere provide information on air density and temperature at various altitudes. Today the cosmonauts will prepare the "Yelena" small gamma telescope for tomorrow's operation. They will perform medical studies,

including measurement of body mass and evaluation of muscle condition. Yesterday the crew performed geophysical studies, including photography of land and ocean areas with the MKF-6M and KATE-140 apparatus. (Moscow PRAVDA in Russian 17 Nov 82 p 1)

18 Nov

On 18 November the small earth satellite "Iskra-3" was separated from the orbital complex "Salyut-7"--"Soyuz T-7"--"Progress-16" and inserted into space. "Iskra-3" is intended to continue experiments in the field of amateur radio communication begun by the "Iskra" and "Iskra-2" satellites. The cosmonatus prepared the satellite for launch, checked the operation of its systems and at the scheduled time they inserted the satellite into open space through an air lock. The satellite's orbit has the following parameters: apogee, 365 km; perigee, 350 km; inclination, 51.6 degrees; period of revolution, 91.5 minutes. The satellite carries a repeater apparatus for experiments in amateur radio communication, a storage unit, a command radio line, power supply system and a telemetry system for transmission of data to earth. "Iskra-3" was created by a student design bureau of the Moscow Aviation Institute imeni Ordzhonikidze. Student command and receiving points are located in Moscow and Kaluga. Telemetry measurements show that all systems are functioning normally. (Moscow PRAVDA in Russian 19 Nov 82 p 3)

19 Nov

Cosmonauts Berezovoy and Lebedev have completed 190 days in orbit. In recent days the cosmonauts have used the "Yelena" gamma telescope to make a series of measurements of streams of gamma radiation and charged particles in near-earth space. The "Gel'" (gel) experiment has been completed in the "Svetoblok-T" instrument to study features of the synthesis of polymers in weightlessness. Biological experiments are continuing. In a television report the cosmonauts showed their "orchard" in which they are currently experimentally with 13 species of higher plants. Today the crew is performing scheduled maintenance operations and checking on-board systems and scientific apparatus. Present orbital parameters of the space complex are: apogee, 370 km; perigee, 352 km; period of revolution, 91.5 minutes; inclination, 51.6 degrees. (Moscow PRAVDA in Russian 20 Nov 82 p 1)

23 Nov

The record flight of the cosmonauts is continuing. Today the crew had a scheduled day of medical exams. Checks were made of the condition of their cardiovascular systems and reaction of circulation to measured physical loads and simulated hydrostatic pressure. The cosmonauts also measured their body mass, muscle condition and performed a number of biological studies. Preparations have been completed for use of the new technological apparatus "Korund" for production of semiconductor materials in space. This apparatus, which contains an electric heating furnace, is designed to work with twelve samples in sequence. Automatic equipment makes it possible to perform experiments in space material science not only in manned flight mode, but also in

unmanned flight according to a program previously set up by the crew. In recent days in the "Korund" unit there have been obtained experimental samples of monocrystals of cadmium selenide and indium antimonide. (Moscow PRAVDA in Russian 24 Nov 82 p 6)

26 Nov

Cosmonauts Berezovoy and Lebedev have completed their 28th week aboard "Salyut-7". Recent days have been devoted to astrophysical, technical and medical experiments. The cosmonauts used the RT-4M telescope to study X-ray radiation of Sirius. The necessary orientation and stabilization of the space complex were achieved by using the control system of the "Soyuz T-7" ship. Another materials experiment was to obtain a monocrystal of the semiconductor material cadmium selenide. Ongoing biological experiments are studying the growth dynamics of cultures of wheat and peas. Today's schedule includes training in control of the transport ship, a series of measurements of gamma radiation and charged particles in space and a scheduled melt in the "Kristall" unit. Time is also allocated for physical exercises. (Moscow PRAVDA in Russian 27 Nov 82 p 1)

30 Nov

Yesterday the cosmonauts worked on new methods of orientation and stabilization of the space complex and conducted a cycle of studies of natural resources of the earth. At the request of geologists, the cosmonauts surveyed regions of the Caucasus and northern Kazakhstan using the MKF-6M mutizonal apparatus, the KATE-140 camera and a video recorder. Another materials experiment in the "Kristall" unit has been completed. The schedule for the 202nd day in orbit includes transfer of used equipment from the station into the cargo ship, preparation of the "Korund" unit for new work, experiments in cultivation of higher plants and a television report. A great deal of attention throughout the flight has been devoted to daily physical exercises on the multipurpose trainer and veloergometer. In order to prepare for their return to earth the cosmonauts have begun regular training sessions using the "Chibis" vacuum suit in which decreased pressure creates a flow of blood to the lower part of the body and simulates earth's gravity. (Moscow PRAVDA in Russian 1 Dec 82 p 1)

3 Dec

The cosmonauts have begun their 205th day in orbit. The schedule for today includes a check of the inventory of life support equipment, biological experiments, physical exercises and training with the "Chibis" suit. After completion of preparatory operations, including pumping out of compressed nitrogen from the fuel tanks of the unified engine unit of the station, the tanks of "Salyut-7" will be refilled with fuel. Yesterday the crew underwent scheduled medical examinations. Experiments were also performed to evaluate the sanitary and hygienic conditions aboard the station. Results of the medical studies showed that both cosmonauts are in good health. The commander's pulse rate is 60 beats per minute; the flight engineer's rate is 70 beats per minute. Their arterial pressures are 130 over 60 and 130 over 70 mm Hg, respectively. (Moscow IZVESTIYA in Russian 4 Dec 82 p 1)

7 Dec

Cosmonauts Berezovoy and Lebedev have been working in orbit for 208 days. According to the planned program the cosmonauts are concluding their studies and experiments on "Salyut-7" and are preparing the station for flight in automatic mode. The cosmonauts will stow the station's scientific apparatus, transfer the gear to be returned into the descent craft of the "Soyuz T-7" ship and check out its on-board systems. Planned operations to refill the station's tanks with fuel and oxidizer from the cargo ship's tanks have been fully completed. Tomorrow an orbital correction of the complex will be carried out using the engine of "Progress-16". In the "Korund" unit the material science experiment begun on 6 December is continuing. The goal of the experiment is to obtain monocrystals of cadmium sulfide and germanium sulfide alloyed with germanium. (Moscow PRAVDA in Russian 8 Dec 82 p 1)

9 Dec

The longest flight in the history of manned spaceflight is nearing its conclusion. Cosmonauts Berezovoy and Lebedev have completely carried out the program of scientific research on "Salyut-7" and they will return to earth tomorrow. In accordance with the plan for preparing the "Soyuz T-7" for descent from orbit, the crew is checking out its on-board systems and transferring and stowing containers with experimental materials in the descent craft of the ship. Used equipment is being place in the ship's orbital compartment. Amont the items to be returned to earth are: flight documentation, cassettes with exposed motion picture and still film, inserts with biological objects and ampules with monocrystals of semiconductor materials. Today the cosmonauts are carrying out the schedule for stowing scientific apparatus and equipment on the station. They are also taking samples of air and microflora for subsequent laboratory analysis. Physical exercises and training with the "Chibis" vacuum suit are also scheduled. (Moscow IZVESTIYA in Russian 10 Dec 82 p 1)

10 Dec

As was already reported, the cosmonauts are returning to earth today. According to ballistic data, the "Soyuz T-7" descent craft will land late in the evening. In their last hours aboard the station the crew carried out final operations to deactivate the station's on-board systems and went over the inventory and packing of the equipment to be returned with specialists at the Flight Control Center. After transferring to the transport ship, the cosmonauts secured the hatch and prepared for the descent from orbit. (Moscow IZVESTIYA in Russian 11 Dec 82 p 1)

10 Dec

The 211-day manned flight, longest in the history of cosmonautics, has been completed successfully. At 2203 hours Moscow time on 10 December, cosmonauts Berezovoy and Lebedev returned to earth after completing the

planned program aboard the "Salyut-7" orbital scientific complex. The "Salyut-7" station continues in flight in automatic mode. The ship's descent craft landed in the planned region of the Soviet Union 190 kilometers east of the city of Dzhezkazgan. A medical examination of the cosmonauts at the landing site showed that they had withstood their long stay in space well. (Moscow PRAVDA in Russian 11 Dec 82 p 1)

CSO: 1866/56-P

DESCRIPTION, PHOTOS OF 'SALYUT-7' STATION

Moscow ZEMLYA I VSELENNAYA in Russian No 6, Nov-Dec 82 pp 11-16

[Article by K. P. Feoktistov, doctor of technical sciences, USSR flier-cosmonaut, HSU, and E. K. Demchenko, candidate of technical sciences]

[Text] The "Salyut-7" orbital station was launched on 19 April 1982. It continued the program of regular manned flights. The station is described by participants in its creation.

*****

Principal Results of Flight of "Salyut-6" Station

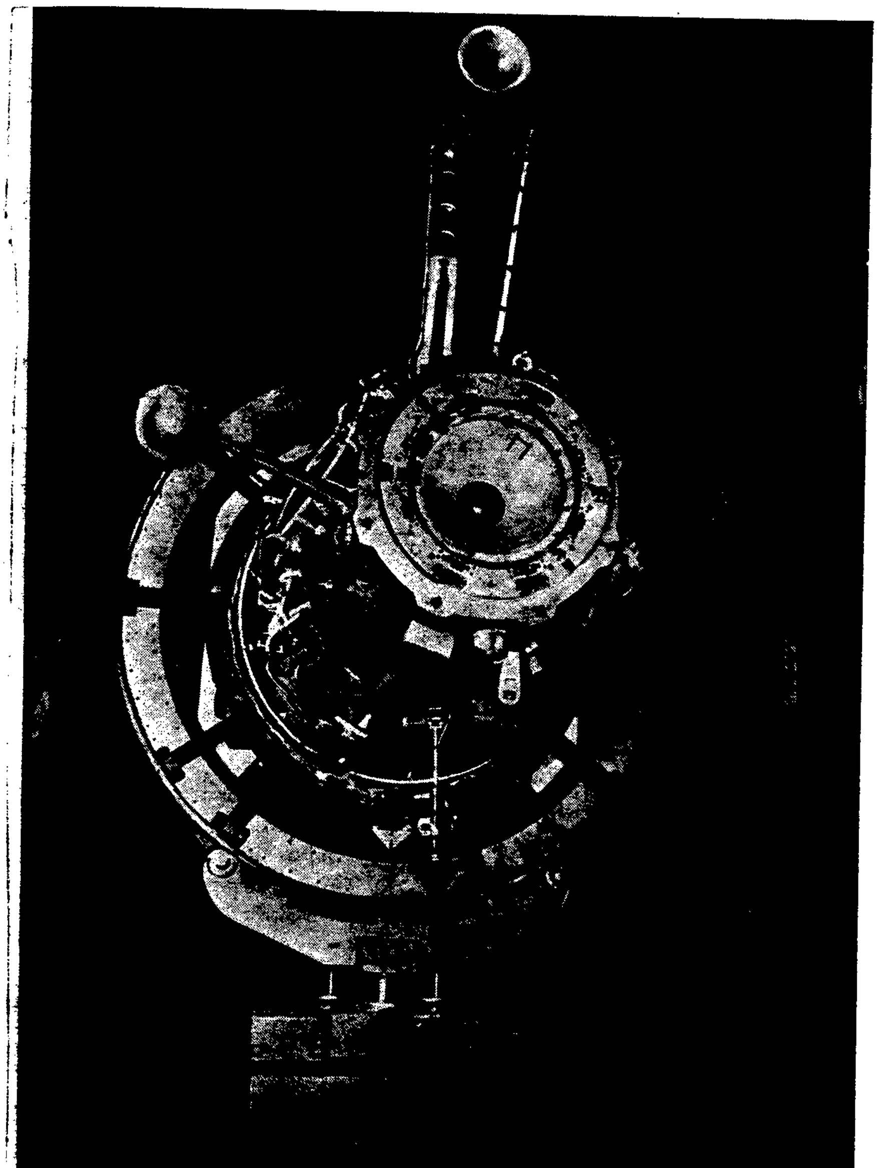
At the time of launching of the seventh "Salyut" station the "Salyut-6" had been in space for more than 4.5 years. Sixteen expeditions worked aboard it, including: 5 main expeditions (with a maximum duration of 185 days), 10 visiting expeditions (each with a duration from 3 to 7 days) and one expedition for carrying out repair-reconstruction work. The planning of the flight program took place with the participation of cosmonauts from the socialist countries (9 international expeditions). Using 12 ships of the "Progress" type about 20 tons of freight were delivered to the "Salyut-6" station. A highly complex operation was performed -- the docking of the ship with the station. A ship of the new series "Soyuz T" was tested and given its "credentials." Scientific and economic investigations were carried out. Experience was acquired with prolonged manned flights and repair-reconstruction work in space. A study was made of the behavior of materials and instrumentation under conditions of a prolonged space flight.

The work program of the "Salyut-6" has been completed. In the final stage of the flight of the "Salyut-6" (the artificial earth satellite "Cosmos-1267," intended for perfecting the design of promising space vehicles) there were tests of materials and instruments under conditions of a prolonged flight in an automatic regime. The Flight Control Center had to control two stations simultaneously: "Salyut-6" and "Salyut-7."

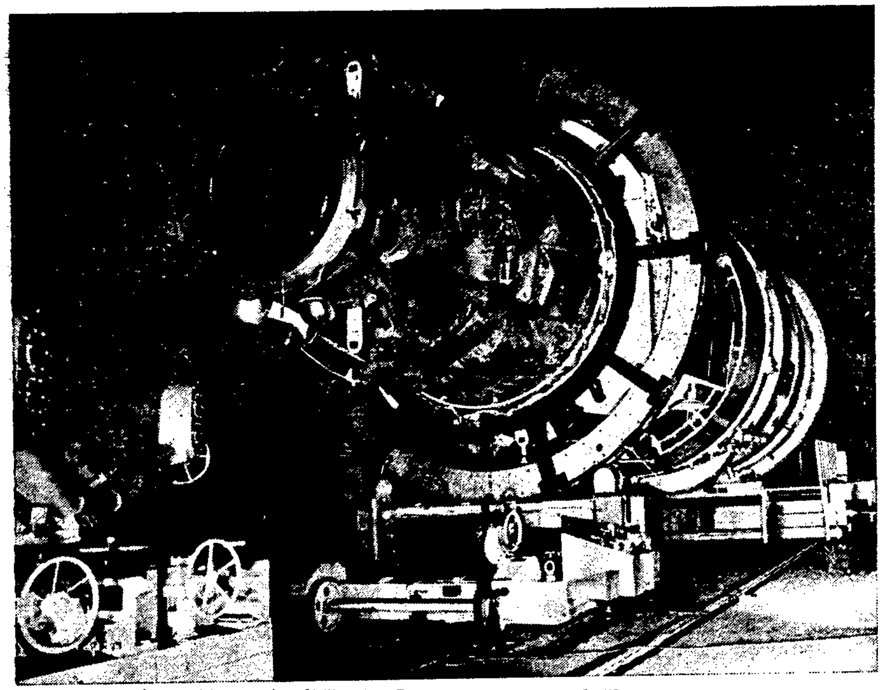
Differences Between the "Salyut-7" and "Salyut-6"

The "Salyut-7" is a station of the same class as the "Salyut-6" (ZEMLYA I VSELENNAYA, No 5, pp 10-17, 1981 -- Editor). It is intended for flights in the same orbits (altitude 300-400 km, inclination 51.6°); it has similar working and transfer compartments, an intermediate chamber, a compartment for scientific instrumentation and a service module. The makeup of the instruments and equipment, the range and principal characteristics of the service

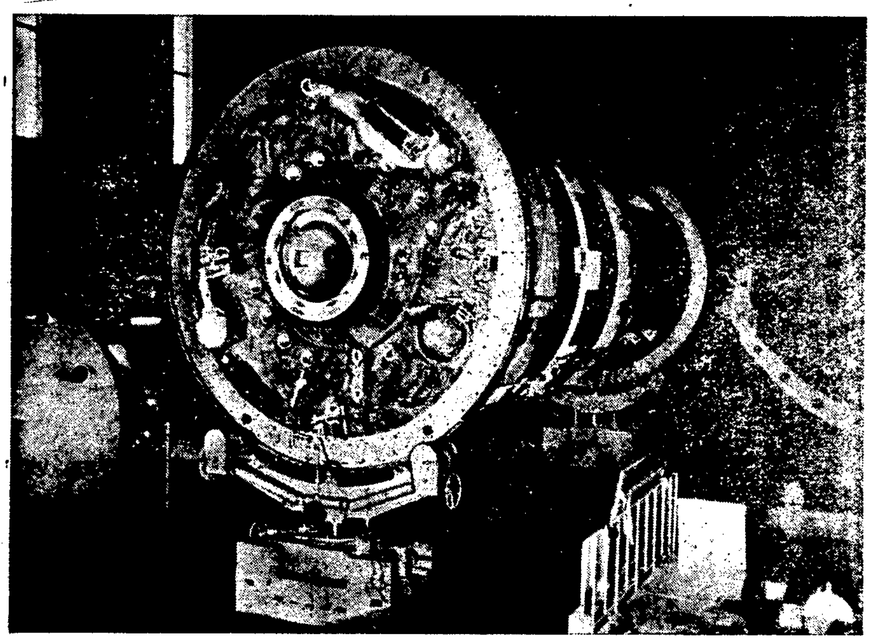
systems, are similar. The principal differences are related to new investigations and experiments (an x-ray telescope, instruments for surveys of the star sky with the use of image converters, new spectrometers, equipment for technological experiments, improved biomedical equipment, instruments for visual observations and investigations have been installed). The possibility of repair of the heat regulating system and radio systems has been eased; external covers have been introduced for the windows; conditions for the life and work of the crew have been improved; there has been an increase in the power of the electric supply system; the processes of control of service and scientific instrumentation have been automated. The comments of the cosmonauts flying in the "Salyut-6" have been heeded. The shortcomings which they have noted have been eliminated.



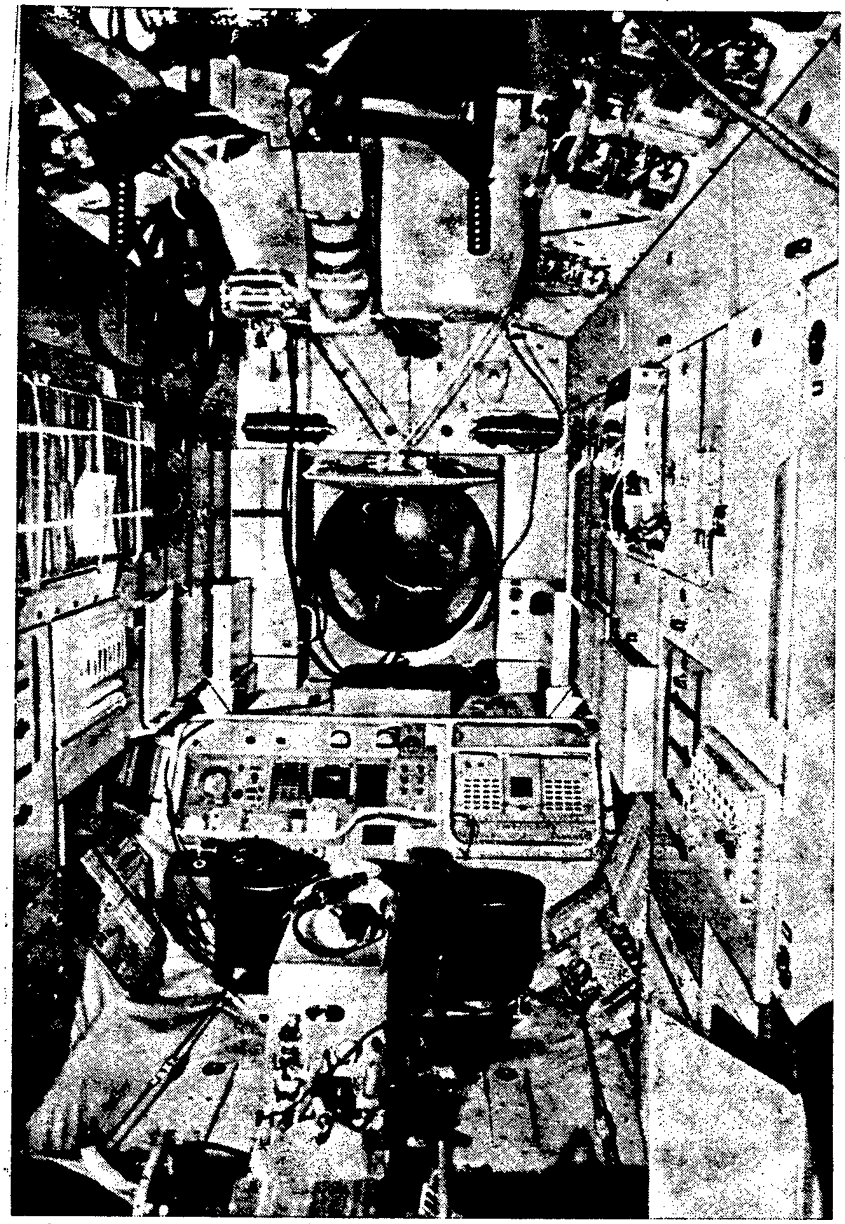
View of "Salyut-7" station from direction of transfer compartment.



"Salyut-7" station in assembly-testing building at Baykonur.



View of "Salyut-7" station from direction of service module.

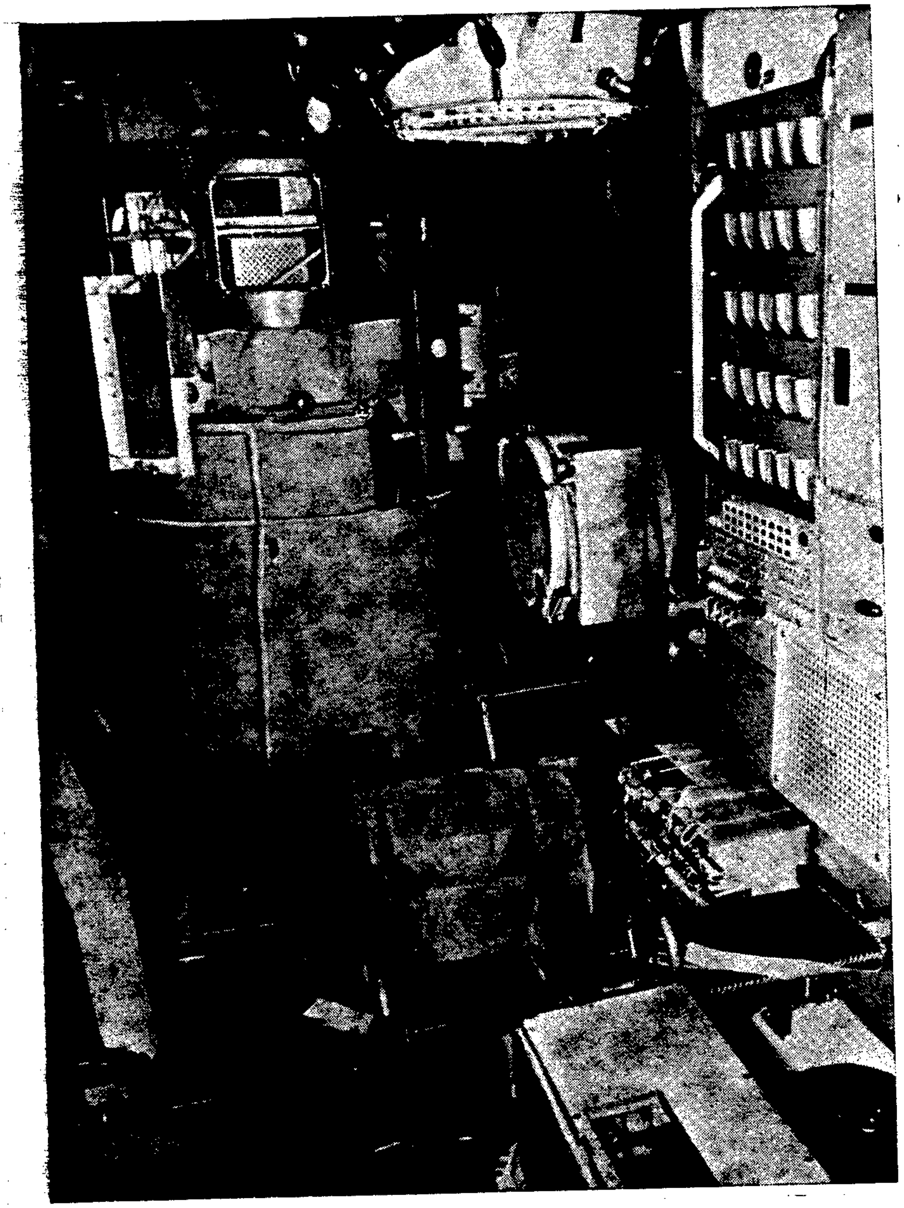


Working compartment of "Salyut-7" station. View toward central control post and hatch of transfer compartment.

There has been an improvement in the service systems of the "Salyut-7." The role of the on-board computer complex in control of operation of the servicing and scientific apparatus has been intensified; the crew has been ensured the receipt of operational information.

The drinking water delivered in the tanks of the "Progress" ships is pumped into containers of the "Rodnik" system, now installed in the unsealed assembly compartment, and not into containers placed in the living compartments, as was the case on the "Salyut-6." This made it possible to free the small living spaces from excess objects and simplify the operation of charging with water.

There is a refrigerator for the storage of quickly spoiling foods; this is in the working compartment of the "Salyut-7" station (capacity 50 liters, temperature +3°C).



Working compartment of "Salyut-7" station. Zone of arrangement of scientific instrumentation compartment: treadmill (bottom left) and shower (upper right).

A new scheme for feeding the cosmonauts (gastronomic or buffet scheme) will be tested. Aboard the "Salyut-6" there was packaging of food in daily packets, a scheme which has been retained from the time of the first manned flights. But it was found that the tastes of the cosmonauts change even in the course of a flight and the rations planned a half-year before a flight often ceased to please the crew, which often led to the loss of food. Now, however, a cosmonaut

can, as he desires, plan his daily ration, maintaining a stipulated daily calorie level. It is true that for the "earth" such a scheme makes it difficult to inventory and replenish the food.

Other elements of the life support system have also been modernized: the "shower" has become more convenient; the packets of regenerators and filters for the purification of harmful impurities in the atmosphere of the sealed compartments have become more compact and are more easily replaced.

It should be noted that other equipment which must regularly be delivered to the station has also become more compact and lighter. The high cost of delivery of freight and the deficit of living space on the station at all times makes it necessary to think about a decrease in the size and mass of the equipment and apparatus.

Outside, on the station walls, there has been an increase in the number of fixation elements (cleats, hooks), which makes it possible to broaden the scope of work in open space. There has been an increase in the maximum time during which the cosmonauts can remain in spacesuits outside the sealed compartments, up to 5 hours in comparison with 3.5 hours on the "Salyut-6." There has been an increase in the operating time of the heat regulation system. This is attributable to the fact that during the time of operation of the "Salyut-6" we met with the necessity of its repair. The crew of the ship "Soyuz T-3" (L. D. Kizim, O. G. Makarov, G. M. Strekalov) during the time of the repair-reconstruction work aboard the "Salyut-6" installed new hydraulic units, "cutting into" the main hydraulic lines, not having the necessary "joints" for this purpose. The cosmonauts were forced to use special measures against the leakage of fluid from these lines. On the "Salyut-7" such an operation was provided for in advance and it can be performed rapidly, simply and reliably due to the use of joints with valves in the hydraulic lines. These valves do not allow the fluid to flow out when the pipes are disconnected. Provision has been made for the possibility of in-flight charging of the lines.

Allowance has been made for the experience acquired at the time of the additional fuel charging of the combined "Salyut-6" engine; tanks with fuel were reliably safeguarded against damage.

The docking unit on the transfer compartment, which is subjected to the greatest amplitude and number of load cycles, became more durable.

The problem of preservation of the windows was fully recognized only after the many years of work with the "Salyut-6" station. It must be admitted that this problem was earlier underevaluated. It was found that the glass surfaces of the windows as time passes are contaminated and are damaged both on the outside and on the inside. Within the station the window glasses can be contaminated by particles floating in the atmosphere; the cosmonauts can scratch the glass with the instruments at the time of work. It is quite simple to clean the glass from contaminants from within. But in order to preclude random damage to the glass use has been made of protective rubber rings and supports on the instruments.

It was more difficult to protect the windows from the outside. The reason for the mechanical damage to the glass was micrometeorites, from which after several years of flight "caverns" of different size appeared on many windows of the "Salyut-6" station. A cloud formed by gases and by sublimation of materials and surrounding the station, as well as by combustion products which are ejected by the orientation engines, serve as the basic sources of contamination of the external glass of the windows. An experiment related to the mechanical cleaning of the windows and carried out by V. V. Ryumin during emergence into open space, did not yield positive results. Accordingly, on the "Salyut-7" station there was a limited use of materials which could become the sources of contamination of the atmosphere around the station and transparent covers were placed on the main windows, opened and closed by means of electric drives.

There was a considerable improvement in the living conditions for the cosmonauts and the station became more comfortable: the seats of the central control post became less unwieldy; the living compartments were illuminated more brightly; there was an increase in the number of electric plugs which are used for connecting the on-board and scientific equipment; there was an increase in the number of rubber fixers on the panels of the working compartment for the attachment of different small objects (otherwise in a state of weightlessness everything floats away and is lost); provision was made for delivery to the station and installation of a color videomagnetic recorder in combination with a newspaper television camera and also a stereophonic magnetic recorder; in order to ensure cleaning of the panels of the living compartments use was made of a material which is easily cleaned in the case of contamination.

Research Program

The research program on the "Salyut-7" station was revised and expanded. We will discuss it in greater detail.

Astronomy and atmospheric physics. Investigation of x-ray sources (telescopes and spectrometers with a measurement range 2-25 keV); study of the background fluxes of gamma quanta and charged particles ("Yelena" gamma telescope); registry of ionizing cosmic radiation ("Ryabina" radiometer, portable dosimeters); investigation of meteor matter in the upper layers of the atmosphere (the "EFO" apparatus -- produced by the CzSSR), the flux of micrometeors (MMK apparatus), earth's upper atmosphere and the atmosphere around the station ("Astra" apparatus); photographic observations of the earth's atmosphere, interplanetary and interstellar space in the visible and near-infrared range (French PIRAMIG and PCN cameras).

Investigations of the earth. Photographic studies and spectrophotometric measurements of the earth for creating maps, study of forested areas and agricultural fields, search for minerals, monitoring of the environment (multizonal MKF-6M camera produced in East Germany, KATE-140 camera, "Spektr-15" spectrophotometer produced in Bulgaria, hand-held spectrometers, photometers and cameras, binoculars).

Technological experiments. Study of the mechanism of mass transfer, anisotropy of the rate of growth of crystals and perfecting of the processes of production of semiconductors in the presence of microgravitation ("Magma," "Korund"

industrial furnaces); fundamental investigations of the processes of crystallization in a state of weightlessness ("Kristallizator" industrial furnace produced in the CzSSR); study of the influence of microgravitation on the growth of crystals ("Splav" industrial furnace); application of thin-film coverings ("Isparitel'" apparatus); production of construction parts by the foaming and hardening of plastics ("Lotos" apparatus); study of the characteristics of materials under spaceflight conditions ("Resurs," "Elast," "Spiral'" instruments).

Biomedical experiments. Clarification of the possibility of isolation of biological substances by the electrophoresis method ("Tavriya" apparatus); evaluation of the conditions of habitation and functioning of the state of man ("Aelita" medical apparatus, instrument for measuring mass, noise meter); investigation of the transpiring of vital processes at the cellular and subcellular level for different bioorganisms ("Biogravistat," "Oazis," "Tsitos-2").

Last Stages in Preparation of "Salyut-7" on Earth

While being still on the earth, the "Salyut-7" was already in operation: at the station the assumptions were checked and it was possible to refine variants for the elimination of shortcomings noted during operation of the "Salyut-6." Specialists checked out the operations of repair or replacement of apparatus by the cosmonauts, new scientific and service equipment then delivered to the "Salyut-6."

During the final stage of preparations on the "Salyut-7" station there were training sessions for its future crews. The station underwent the last cycle of electric tests and also tests for tightness in a vacuum chamber. The final mass and coordinates of the center of gravity were determined on a balancing stand, in accordance with which the axes of the station propulsion engines were adjusted.

An important stage in preparation of the station was the "author's inspection." In this stage the station is virtually completely ready; it is subjected to a careful inspection by the representatives responsible for different systems and designs of the station (its "authors). The noted shortcomings and the arising doubts are discussed and eliminated. This operation is mandatory under the technological preparation plan; it makes it possible to increase the quality of preparation and to avoid possible perplexities.

On 27 March at Baykonur the crews of a Soviet-French expedition inspected the "Salyut-7" station. Then Soviet crews became acquainted with how their wishes, expressed in the last training sessions, had been taken into account and realized on the station. All the station systems were put into the initial state, that is, prepared for operation in those regimes which are required at the beginning of station flight, after its separation from the carrier-rocket. After fueling of the combined engine, the "Salyut-7" station was joined to the carrier-rocket and was moved to the launch pad. It was launched at night. The carrier-rocket with the station, illuminated by searchlights, it appeared, was illuminated from within. The spectacle was effective and exciting even for those who had watched many launchings. The vehicle was put into orbit in accordance with plan.

Onset of Flight

After the vehicle was put into orbit and the station was separated from the carrier-rocket the telemetric information made known that the deployment of all station components, including antennas and panels of solar cells, transpired without problems and the tightness and temperature of the compartments was normal.

The "Salyut-7" station successfully began its flight.

In accordance with the λ-characteristic (as it is customary to call the curve of change in the intensity of failures as a function of flight time), in the first stage, which includes the flight segment without a crew and the onset of manned flight, one should anticipate a maximum intensity of failures. And in actuality, the operation of some station systems was less than perfect, but all the malfunctions were within the limits of the anticipated possibilities of back-ups and repair, exerted no influence on functioning of the systems and were eliminated.

The engine put the station into a working orbit. The first crew of the "Salyut-7" station -- A. N. Berezovoy and V. V. Lebedev -- was launched in the "Soyuz T-5" ship on 13 May, and after a day, after the docking, proceeded to carry out their work program on the station (ZEMLYA I VSELENNAYA, No 4, pp 2-3, 1982 -- Editor).

5303
CSO: 1866/43

NEW FEATURES OF 'SALYUT-7' STATION

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 9, Sep 82 pp 44-45

[Article by A. Aleksandrov: "Salyut-7"]

[Text] Externally the "Salyut-7" orbital space station differs little from its relative, but it is not a copy of it. The modernization of the "Salyut-6" station made it possible to improve the efficiency of equipment operation, expand the program of scientific and technical research significantly, and create more comfortable working and resting conditions for the crew.

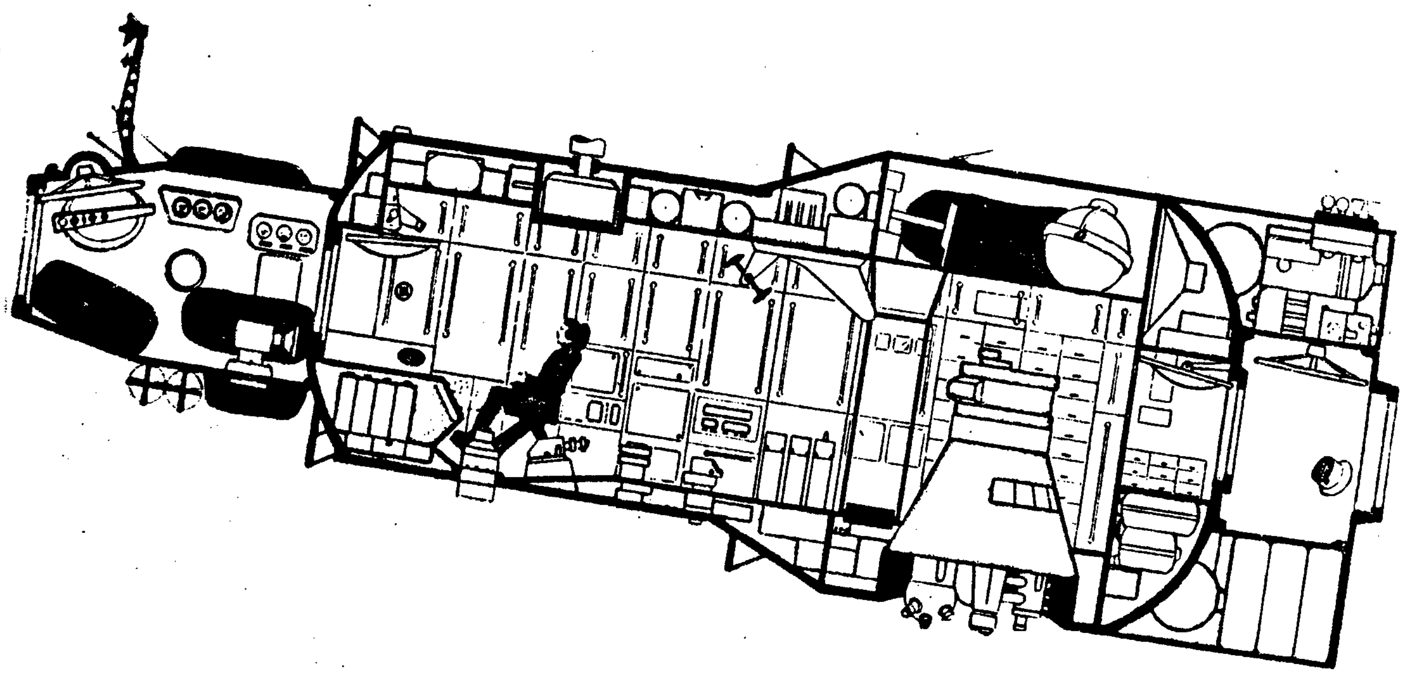
The station consists of three sealed compartments (one working and two transfer compartments that lead to the docking units) and two unsealed ones (the service and scientific equipment modules). It is about 15 m long, the greatest diameter of the sealed section is barely 4 m, and the span of the solar battery panels is 17 m. Two docked ships increase the space complex's length to 30 m.

In external appearance, the three solar battery panels do not differ from those that supplied the "Salyut-6" with electricity. However, this electrical generator's power is about 10 percent greater because of an increase in the specific capacity of the panels' photoelements.

There is yet another innovation: several windows are covered on the outside with transparent covers that make it possible to preserve their clarity despite the fact that the station will be struck repeatedly by meteor showers while in flight. The covers can be removed during an experiment.

The scientific equipment module underwent the greatest changes. A complex of X-ray equipment was placed in it instead of the submillimeter BST-1M telescope.

The horizontal layout, in which the "floor" and "ceiling" are parallel to the station's longitudinal axis, has been preserved in the "Salyut-7." The control stations for the service systems and scientific equipment are well placed, along with a minigymnasium (including a veloergometer and a running track), two airlocks and sleeping areas. The new house in space is more comfortable. It is brighter inside although the total number of illumination lamps has not been increased; instead, they are placed differently. The spectral composition of the light has been changed also, in order to insure better light transmission when surveying with color photographic and moving picture film. Aircraft-type chairs have disappeared from the main control station. As it turned out, under conditions of weightlessness it is sufficient to have a small portable chair and leg restrainers.



Several other structural changes created additional comforts for the crew. Bracing elements were added for the tools and writing equipment with which the cosmonauts work. New objects adapted especially for disconnection from electrical sockets also appeared. Access to a number of units was made easier, which reduces the amount of time needed to perform maintenance work and improves its quality. Several cumbersome units of the life support system were separated into their component parts. This makes it easier to handle them.

Portable miniature radio sets enable cosmonauts in different areas of the complex to communicate with each other without turning on the intercommunication system, which is located only at the control stations. Through a retransmitter installed in the working compartment the crew can exchange information with Earth.

On board the "Salyut-6" the "Del'ta" navigation system was one of the experimental systems. It is now one of the standard ones. Its functions are extremely variegated: navigational calculations, turning the radio equipment on and off during communication sessions, producing reference information. The computer's role is especially important during the conduct of scientific research requiring the aiming of equipment at certain objects in space. The station's operating program for a considerable length of time (for several orbits, for example) is entered in it. Then, at the previously calculated time, the computer issues commands to the orientation system to turn the station and aim the scientific equipment at the necessary objects in space, after which the equipment turns itself on. Research utilizing the X-ray complex is carried out in just this way.

One of the airlocks that is used to eject waste containers from the station was modernized for the "Salyut-6." As a result there appeared the possibility of placing in it a "Splav-01" process furnace and other installations for scientific research.

Now a second airlock has also been improved, which makes it possible to enlarge the circle of work involving experiments utilizing the vacuum outside the station.

Another thing that has been modernized is the thermal control system. In contrast to some other ones, it operates continuously. Although the external and internal hydraulic circuits have backups, the service life of the hydraulic units in them is still limited. On the "Salyut-7" it is possible to replace panels with faulty hydraulic units, as well as to top off the system with liquid and gaseous components while in flight.

The long durations of our flights forced us to take a new look at the feeding of cosmonauts. From now on a crew can select a meal according to its own preferences, as long as it remains within the limits of the recommended menu. This possibility is the result of the introduction of the so-called "snack bar-gastronomic" delivery and storage of food products: at the cosmonauts' request, their favorite dishes are sent to the ship, including borshch and broths, pates, juices, condiments and the like. Thus, there are no more integrated meals.

On board the "Salyut-7" there is a real water line carrying cold water. The "Rodnik" [Spring] (as the system is called) has a reservoir consisting of two tanks holding a total of more than 400 liters. These tanks are located in the station's service module and supply water to the "kitchen" and through a faucet. Everything is just the way it is on Earth. The reservoir is refilled from analogous tanks carried by "Progress" cargo ships.

As before, hot water is produced by the atmospheric moisture regeneration system. It has already proven itself by supplying the crew of the "Salyut-6" with more than 600 liters of boiling water. The old shower system had an electric heater as part of its equipment. Now the cosmonauts can first have a steam bath before they begin water procedures.

The "Salyut-7" is a multipurpose orbital laboratory that is intended for astrophysical, geophysical, medicobiological and other investigations and experiments under spaceflight conditions.

Astrophysical research is carried out with a large complex of scientific equipment on board the station. This complex weighs about 500 kg. The instruments are located in open space and in the scientific equipment module. They are used to analyze the spectral composition and temporal variations of flows of X-ray radiation and to study cosmic objects that are presumed to emit X-ray radiation. Their prototypes functioned successfully on board the "Salyut-4." However, they are still qualitatively new instruments.

The useful area of the detectors, for example, has been increased by a factor of 10, which more than triples their sensitivity to radiation. When the utilization of a number of devices reducing the effect of the background of charged particles is taken into consideration, it can be expected that the actual sensitivity will increase by a factor of five or six.

The basic tools of the geophysical research complex are already well known to the reader: the MKF-6M and KATE-140 cameras, spectrometric equipment, portable photographic and optical equipment.

As far as medical research on board the "Salyut-7" is concerned, the accent is on studying the conditions under which the cosmonauts live in the station. The composition of the atmosphere and its dust level are analyzed, along with the level of the noise produced by the various pieces of equipment. The study of the crew's psychological mood occupies an important place. The reason for this is the changeover to extended, multimonth expeditions, when the station functions simultaneously as home and work place, gymnasium and movie theater for the cosmonauts; in other words, it is their entire environment.

The biological equipment (about 10 different installations) is used to investigate different biological objects under space conditions. They are delivered to the station and returned to Earth on board manned "Soyuz T" transport ships.

In all, on board "Salyut-7" there are several dozen large and small instruments, but the composition of the equipment for the implementation of the extensive program of scientific and technical work is not limited to the ones now in the station. In the future, "Progress" cargo ships will deliver other instruments to the station, as was done for the realization of the Soviet-French cooperative program. The space expedition continues.

11746
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FIRST SOVIET-FRENCH MANNED FLIGHT

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 82 pp 12-16

[Article by A.V. Filipchenko, Hero of the Soviet Union, USSR pilot-cosmonaut, and V.A. Men'shchikov: title as above; passages rendered in all capital letters printed in boldface in source]

[Text] In 1982 yet another country--France--will have a cosmonaut. A French pilot will be lifted into space, along with his Soviet colleagues, by a Soviet ship.

France was one of the first Western powers to begin investigating space. The National Committee for Space Research was created in France in 1959, and 3 years later was converted into the National Center for Space Research (CNES). This center prepares space programs and proposals for the financing of France's space activities (ZEMLYA I VSELENNAYA, No 2, 1980, pp 51-56).

Planned Soviet-French cooperation began after the conclusion, in 1966, of an intergovernmental agreement on collaboration in the conquest and study of space for peaceful purposes. In the agreement it was emphasized that the development of cooperation between the two countries will facilitate mutual understanding, the strengthening of friendly relationships, and the acceleration of scientific and technical progress in both nations. The agreement provided for the launching of French satellites on Soviet launch vehicles, the installation of instruments developed in France in Soviet spacecraft, and the implementation of joint projects for the needs of meteorology, communications and physics, among others. This cooperation has been expressed in the performance of dozens of experiments in almost all the most important areas of space research. Interplanetary and orbital stations, satellites, and high-altitude rockets and aerostats have been used in the joint projects.

After establishing mutual understanding and business contacts, the successful investigations carried out according to the planned program made it possible to move on to the next phase of space research: a joint manned flight into space. An understanding about this was reached in the course of a meeting, in April 1979, between CPSU Central Committee General Secretary and Chairman of the Presidium of the USSR Supreme Soviet Comrade L.I. Brezhnev and the president of the French republic, V. Giscard d'Estaing. In accordance with this agreement, bilateral working groups were set up for the detailed development of a scientific experiment and research program, the determination of the scientific equipment to be used, and the latter's correspondence to the requirements of a joint flight into space.

Simultaneously with the development of the program for the joint flight and the building of the experimental equipment, the selection of candidates for participation in the flight began in France. From the end of October to 15 November 1979, about 260 applications were received. From this group, six people who had been approved by the committee and were studying Russian at the same time were chosen for a thorough medical examination. Two cosmonauts were selected. French Air Force Lieutenant Colonel (Jean-Loup Chretien), bearer of the Order of the Legion of Honor, was born in 1938. He finished military flight school in 1962 and test pilot school in 1970. By the time he was approved as a cosmonaut candidate he had accumulated more than 5,000 hours of flying time. French Air Force Major (Patrick Baudry) was born in 1946. He finished military flight school and test pilot school in 1970 and 1978, respectively. P. Baudry had 3,000 hours of flying time.

Before arriving at Zvezdnyy Gorodok on 8 September 1980, the French cosmonauts continued their intensive (10 hours per week) study of the Russian language, giving special attention to technical and space terminology. By the middle of 1981, they had successfully completed the general space training course at the Cosmonaut Training Center imeni Yu.A. Gagarin and were continuing to improve their knowledge of Russian. The cosmonauts from France received the required knowledge of the theoretical principles of cosmonautcs and were then concerned with general-physical and medicobiological training.

The spaceflight training phase began for the cosmonauts in the fall of 1981. This involved studying the transport ship, the station and the scientific equipment, as well as training as part of a crew (ZEMLYA I VSELENNAYA, No 2, 1978, pp 5-10). The French cosmonauts also trained for their flight in France.

On 19 October 1981, the supervisor of Soviet cosmonaut training, Lieutenant General of Aviation V.S. Shatalov, USSR pilot-cosmonaut and two-time Hero of the Soviet Union, introduced to French and Soviet journalists the crews that had been selected for the upcoming joint flight.

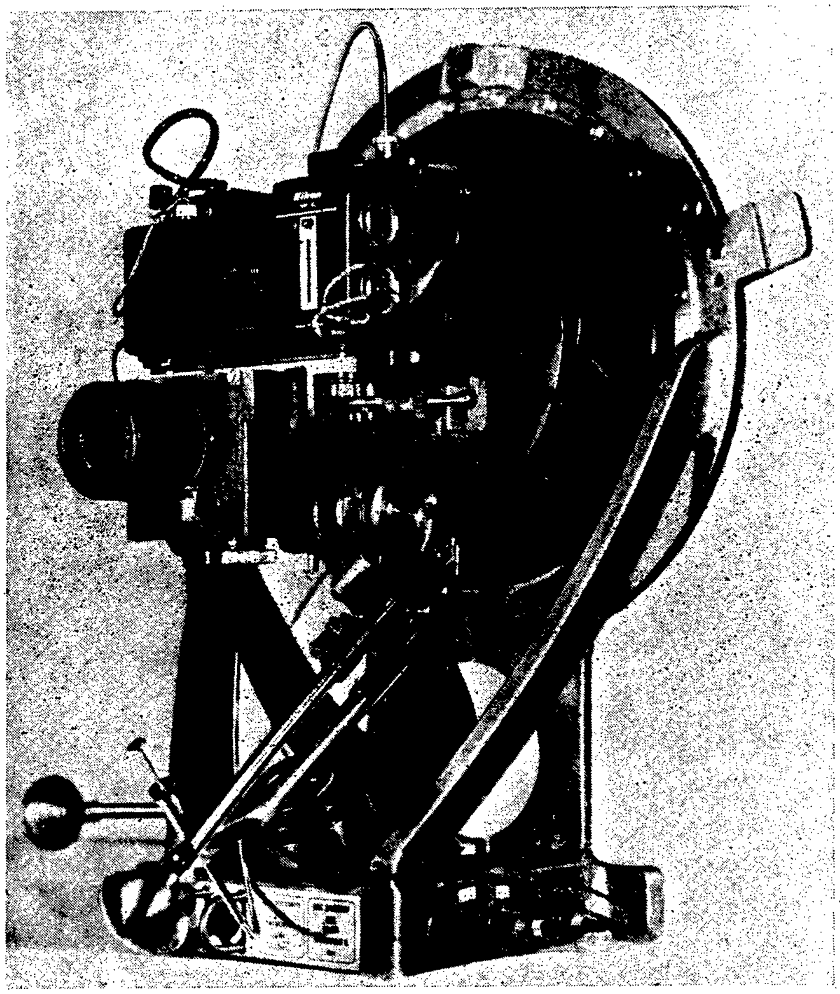
The first crew: crew commander--USSR Pilot-Cosmonaut YURIY VASIL'YEVICH MALYSHEV, Hero of the Soviet Union; flight engineer--USSR Pilot-Cosmonaut ALEKSANDR SERGEYEVICH IVANCHENKOV, Hero of the Soviet Union; cosmonaut-investigator--Jean-Loup Chretien.

The second crew: crew commander--USSR Pilot-Cosmonaut LEONID DENISOVICH KIZIM, Hero of the Soviet Union; flight engineer--VLADIMIR ALEKSEYEVICH SOLOV'YEV; cosmonaut-investigator--Patrick Baudry.

Several changes were made in the composition of the crews during training. Yu.V. Malyshev got sick, and the doctors decided to replace him with USSR Pilot-Cosmonaut V.A. Dzhanibekov, two-time Hero of the Soviet Union.

As a result of meetings of the working groups of both countries, which took place in Moscow and Paris, Toulouse and Baku, the program for the joint manned spaceflight on board a long-term Soviet "Salyut" space station was decided upon. It included astronomical and geophysical experiments and research in space technology, the study of materials, medicine and biology.

The first group included experiments in X-ray, gamma-ray and optical astronomy and the physics of the upper layers of the atmosphere.



The PCN photographic camera, used to study the night sky.

X-RAY AND GAMMA-RAY ASTRONOMY. The beginning of joint Soviet-French experiments in this field was an experiment conducted in 1972 with a "Sneg-1" instrument installed in the "Prognoz-2" satellite. The instrument was used to register neutrons in the 0.98-16 MeV and gamma-quanta in the 0.35-11.8 MeV energy bands. Although the first Soviet-French experiment in gamma-ray and X-ray astronomy was "dedicated" to the Sun, the goal of the subsequent ones was to detect and localize discrete cosmic sources of gamma radiation (ZEMLYA I VSELENNAYA, No 3, 1978, pp 44-47).

The program for the Soviet-French manned flight specified a study of galactic and extragalactic sources of X-ray radiation in the 2-800 keV energy band, with

10-percent spectral resolution. The "SIREN'" device was used in this study. It was developed by the Center for the Investigation of Cosmic Radiation, in Toulouse, and the USSR Academy of Sciences' Institute for Space Research, in Moscow.

The "Kollimator" experiment has been planned for the purpose of improving the resolution of gamma-ray telescopes (using a collimator with a grid). The French are suppling the collimation unit and the Soviets are contributing a "Yelena-F" gamma-ray telescope.

ASTRONOMY AND PHYSICS OF THE UPPER LAYERS OF THE ATMOSPHERE. Scientific equipment developed and manufactured by French specialists will be used to carry out astronomical and geophysical investigations on board the "Salyut" station. The equipment consists of the PIRAMIG and PCN photographic cameras. The PIRAMIG is a high-sensitivity camera with an electronic-optical converter that takes pictures in the near-infrared band of the spectrum. It is used to study galactic objects, interplanetary space, the upper layers of the atmosphere and other objects that are not very luminescent. The name comes from the first letters of the French words "Proche InfraRouge Atmosphere, Milieu Interplanetaire et Galaxies," or "Near-Infrared Band of the Atmosphere, the Interplanetary Medium and the Galaxy." The experiment was prepared by CNES's Space Astronomy Laboratory, in Marseilles.

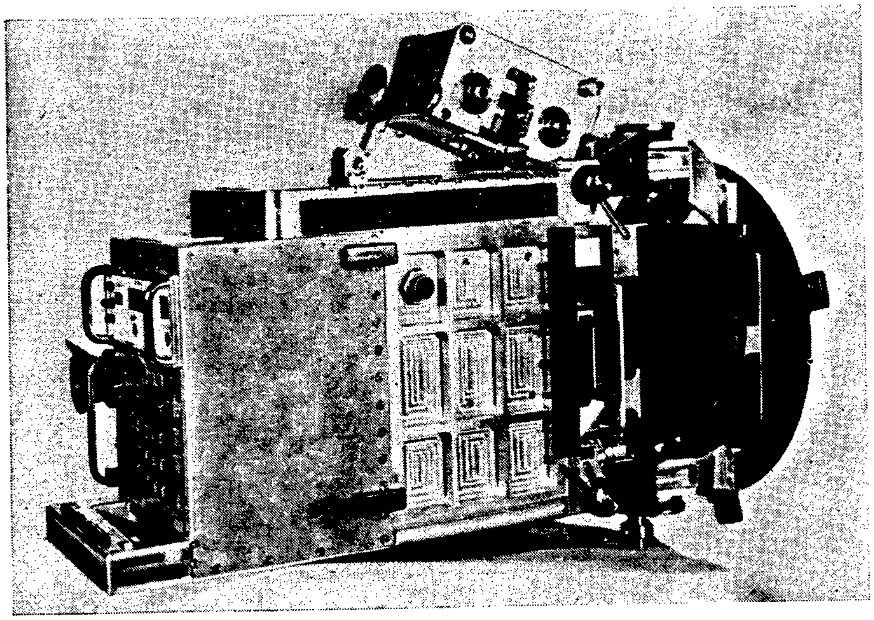
PCN stands for "Photographie du Ciel Nocturne," or "Photography of the Night Sky." This camera, which uses high-sensitivity color and black-and-white film, records the weak luminescence of the night sky, dust clouds in the interplanetary medium and radiation from the upper layers of the Earth's atmosphere. The experiment was developed by the Institute of Astrophysics in Paris.

Both experiments must be conducted when the station is in the shaded part of its orbit.

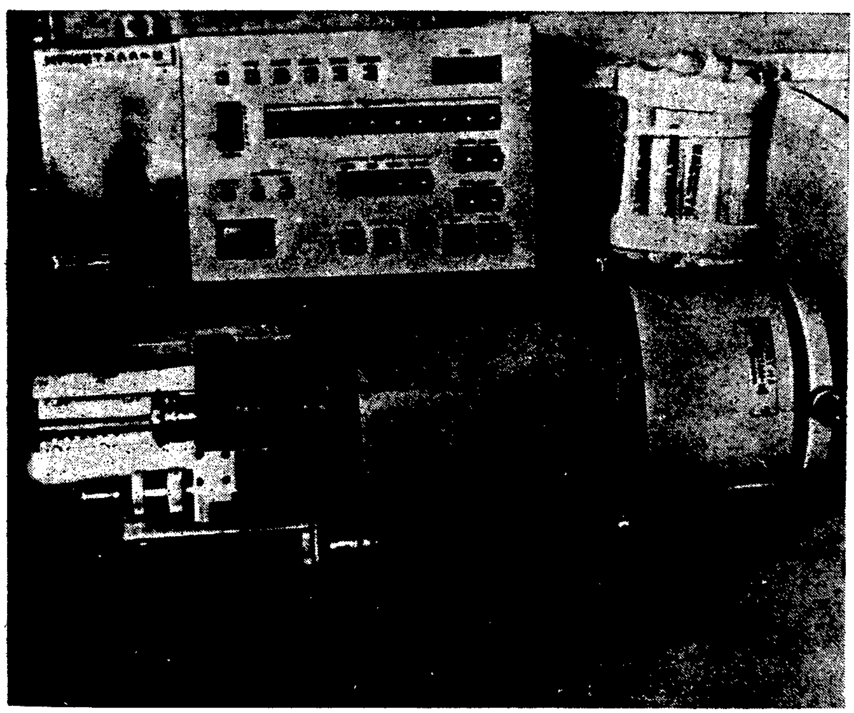
SPACE TECHNOLOGY AND STUDY OF MATERIALS. On board the "Salyut-6" orbital station in March 1979, Cosmonauts V.A. Lyakhov and V.V. Ryumin began the Soviet-French "El'ma" experiment for the study of materials in space. Acting on a French proposal, using Soviet "Kristall" and "Splav" equipment they tried to find out if new materials could be obtained under conditions of microgravity. The positive results of these investigations made it possible to develop a new series of experiments in the field of space technology and study of materials that will be conducted during the joint flight.

"KALIBROVKA" involves the investigation and registration of temperature changes in a "MAGMA" process furnace and inside containers during the process of heating, aging at a given temperature and cooling. The purpose of the experiment is to gather data for the mathematical modeling of the thermal processes that take place under conditions of microgravity. The recording device, the electronics unit and the test containers and thermocouples are being produced by the French. They will also be used to calibrate the Soviet "Kristall" process furnace. The experiment was prepared by the Center for Nuclear Research in Grenoble.

"DIFFUZIYA" involves a study of the effect of microconvection on the phenomenon of transfer in the liquid metal phase in direct proximity to a "solid-liquid" boundary layer. The goal of the experiment is to determine the value of the components' coefficients of mutual diffusion inside the melt, on its surface and in the "liquid-solid" interface. Scientists at Grenoble University created the experiment.



High-sensitivity PIRAMIG photographic camera for taking pictures in the near-infrared band of the spectrum.



"Magma" equipment for conducting research in space technology.

"LIKVATSIYA" (El'ma-2) involves a study of the role of capillary forces in the transformation of the structure of dispersed (scattered) liquids. The experiment will be considered to be completed if the experimenters succeed in observing the fusion of the components, maintaining the alloy in a given temperature range, and controlling the crystallization of alloys at different rates. The experiment was developed by the Center for Nuclear Research in Grenoble.

During the "Diffuziya" and "Likvatsiya" experiments, the level of the residual accelerations acting on the containers will be measured with the help of an accelerometer manufactured by French specialists. A magnetic recorder will be used to record the results.

Upon completion of the program of technological experiments, the containers and the materials that were investigated will be returned to Earth. This is important not only in order to determine the materials' characteristics by all available methods, but also in order to model the technological processes on the basis of the data obtained in space.

MEDICOBIOLOGICAL EXPERIMENTS. The purpose of the "EKHOGRAFIYA" experiment is to conduct an ultrasonic investigation of the heart, blood vessels and internal organs in order to study the special features of the condition of a human being under spaceflight conditions.

"BIOBLOK-3" is a continuation of a series of experiments in the "Bioblok" program that were performed during flights of biological artificial Earth satellites in the "Cosmos" series. These experiments were conducted in order to investigate the biological effect on an organism of the heavy nuclei of galactic cosmic radiation. The results of the experiments will help us to define more precisely the criteria for "radiation hazard" during spaceflight.

In the "TSITOS-2" experiment the cosmonauts will continue studying the kinetics of the propagation of the simplest organisms under spaceflight conditions and will investigate the stability mechanism of micro-organisms and antibiotics. With this in mind, the French developed original equipment for the incubation of the simplest organisms.

The purpose of the "POZA" experiment is to determine how the interaction of the sensory systems is reorganized under conditions of weightlessness.

The materials and equipment developed by the French will be delivered to the orbital station by a cargo ship.

At the end of 1981 the space crews began to study the composition, basic technical characteristics and arrangement of the scientific equipment. In specialized classes they worked with models of the equipment. The cosmonauts are are extremely interested in the scientific experiments that have been prepared by French and Soviet specialists and have offered suggestions on how to prove designs and make it more convenient to work with the devices. In the final account, this will result in the successful realization of the joint scientific program.

11746
CSO: 1866/102

BIOMEDICAL AND TECHNICAL EXPERIMENTS IN FLIGHT OF SOVIET-FRENCH CREW

Moscow PRIRODA in Russian No 9, Sep 82 pp 6-9

[Article by S.A. Nikitin, "Intercosmos" Council, USSR Academy of Sciences, Moscow: "Spaceflight of the Soviet-French International Crew"]

[Text] This flight took place in a year of a whole series of "space" anniversaries: 17 October 1982 marked the 125th year since the birth of K.E. Tsiolkovskiy, the great Russian scientist and founder of theoretical cosmonautics and rocket technology; 4 October 1982 was the 25th anniversary of the launching of the first Soviet artificial Earth satellite, an historical event in the life of mankind that laid the foundation for the space era; 5 October 1982 was the 100th anniversary of the birth of R.H. Goddard, the distinguished American scientist who was one of the pioneers in rocket technology. Examples of less "celebrated" anniversaries can also be presented. For instance, 20 years ago, in March 1962, the first satellite in the "Cosmos" series, a series that plays a very important role in the development of Soviet cosmonautics, was launched.

Of course, one should not see any symbolism in this coincidence of events, but in anniversary years the tendency is to review results and outline new borders, and the flight of the Soviet-French international crew is a worthy "entry" in this tradition.

The collaboration of the USSR and France in the study and conquest of space for peaceful purposes is based on an intergovernmental agreement that was signed in Moscow by the Ministries of Foreign Affairs of both states, on 30 June 1966, during the visit to the Soviet Union of a French delegation led by the president of France, C. de Gaulle.

The agreement provided for the conduct of joint projects to study the physical properties of space, space meteorology and space communications through artificial Earth satellites, as well as the exchange of scientific information, apprentices and scientific delegations. Later the collaboration was extended to new areas of research: space biology and medicine and the study of materials in space, in connection with which special interdepartmental agreements were concluded for the individual projects and programs.

The practical work for the organization of joint space investigations was made the responsibility of the USSR Academy of Sciences' "Intercosmos" Council and France's National Center for Space Research (CNES).

Joint Soviet-French research in space encompasses almost all areas of modern space science. Various Soviet and French rocket and space technology facilities are used for this purpose: automatic lunar and interplanetary stations, artificial Earth satellites, manned orbital stations, research and meteorological rockets, high-altitude drifting balloons and airborne laboratories, as well as ground facilities such as radiotelescopes, special cameras and other tools.

During the 16 years of joint work by Soviet and French research workers, about 40 large projects and programs have been carried out; interesting scientific results that, at the same time, are of important practical value have been obtained in each of the areas of collaboration. These results, which have been widely acknowledged by the worldwide scientific community, are reflected in hundreds of joint publications. During sessions of the "Great" Committee on Economic, Scientific and Technical Cooperation Between the USSR and France, as well as at meetings on the highest level, the Soviet-French collaboration in space has been regularly characterized as exemplary for many years. It is based on a long-term foundation: a program of space experiments that is carefully worked out jointly, by specialists from both countries, and periodically refined and supplemented.

In a short article it is impossible to discuss in any detail the huge amount of joint work done by Soviet and French investigators in more than a decade and a half, so I refer the readers who are interested in this to a pamphlet in which the essence and results of the Soviet-French cooperation in studying and conquering space is explained most fully[1].

The flight into space of the Soviet-French international crew was preceded by a large amount of preparatory work that was done in both the Soviet Union and France. Addressing a press conference on 7 July 1982, Academician A.P. Aleksandrov, president of the USSR Academy of Sciences, mentioned the work on the preparation of the scientific program for this flight that was done jointly by French specialists and specialists from the USSR Academy of Sciences' Institute of Space Research and Institute of Terrestrial Magnetism, the Ionosphere and Radio Wave Propagation and the USSR Ministry of Health's Institute of Medicobiological Problems. On the French side, 22 scientific research institutes and 6 industrial firms participated in the preparation of the research program for the flight and the creation of the scientific equipment.

As a result, there were 14 experiments in the scientific program for the Soviet-French international crew: 9 in the field of space biology and medicine, 2 in astrophysics and 3 for the study of materials in space. They were all related to important areas of space research. The scientific equipment needed to perform them was delivered to the "Salyut-7" orbital station by the "Progress-13" automatic cargo ship. The members of the main expedition--cosmonauts A.N. Berezovoy and V.V. Lebedev--transferred the instruments to the station, tested them and prepared for the work that was to be done.

The Soviet-French international crew was launched from Baykonur cosmodrome, in a "Soyuz T-6" space transport, at 2030 hours (here and further, Moscow time is used)

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[1]Petrunin, S.V., "Sovetsko-frantsuzskoye sotrudnichestvo v kosmose" [Soviet-French Collaboration in Space], Moscow, 1980.

on 24 June 1982. The crew consisted of USSR Pilot-Cosmonaut V.A. Dzhanibekov, ship commander, USSR Pilot-Cosmonaut A.S. Ivanchenkov, flight engineer, and Cosmonaut-Researcher (Jean-Loup Chretien), citizen of France[1]. The "Soyuz T-6" docked with the "Salyut-7"-"Soyuz T-5" orbital complex at 2146 hours on 25 June; at 0100 hours on 26 June the members of the Soviet-French crew transferred themselves to the station.

The international crew began its research work with the "Braslet" medical experiment, the purpose of which was to study the possibility of normalizing blood circulation, thereby improving how cosmonauts felt during the acute period of adaptation. The "Braslet" equipment consists of individual contractable cuffs, made of a flexible elastic material, with a belt to hold them in place, that are worn on top of the flight suit. The cuffs insure that blood is deposited in the extremities, thereby reducing the influx of it into the upper half of the body. Straps are used to tighten them according to how the individual cosmonaut feels (on the tightening straps there are divisions 1, 2 and 3, corresponding to a pressure of approximately 30, 40 and 50 mm of mercury) and, depending on how he feels, are used for 30-60 minutes; over the course of a day, up to 5 of these cycles are carried out. When sensation normalization is achieved, the amount of time spent with the cuffs on and the number of cycles can be reduced. At the end of the working day the "Braslet" prophylactic device is taken off.

The "Poza" experiment investigated the interaction of a cosmonaut's sensory organs and motor system in orbital flight. Under terrestrial conditions any movement is invariably accompanied by the need for active counteraction of the force of gravity and maintenance of the body in a certain stable position (posture). If the bioelectric activity of the muscles of a quietly standing person is recorded and analyzed, it becomes clear that even a vertical posture entails complex dynamic control processes.

In coordinating the muscles' work, the central nervous system utilizes information about the spatial orientation and movement of separate parts of the body, as well as the forces acting on them. This information is received from numerous receptors in the vestibular, visual, muscle-joint and cutaneous sensory systems. Under terrestrial conditions the receptor signals are mutually complementary and enable a person to orient himself spatially quite well and maintain the required body position.

Under spaceflight conditions, in the absence of the accustomed gravity, it is possible for the systems listed above to disagree, with the functions of some being weakened and others strengthened. The vestibular, muscular, joint and cutaneous receptors transmit altered information that differs sharply from what they normally send. Information about the body's position is received primarily from the visual analyzer; thus, the role of vision in a person's spatial orientation and, consequently, in controlling the work of his muscles increases sharply.

A simple natural movement--a rapid raising of the hand while in the standing position--was chosen as the motor problem in the experiment. In this movement participate not only the muscles of the arm, but also those used to maintain posture, primarily the leg muscles. Of particular interest is the fact that the activity of the leg muscles in connection with this movement also depends on the state of the visual

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[1]The backup crew: USSR Pilot-Cosmonaut L.D. Kizim, ship commander, V.A. Solov'yev, USSR, flight engineer, P. (Baudry), France, cosmonaut-researcher.

system. The investigation of this motion under different visual monitoring conditions (normal, "central," with eyes closed) can give valuable information about the relative contribution of the visual and other systems in the reorganization of sensomotor interaction.

The equipment used in the performance of this experiment was developed and manufactured in France. It consisted of a platform to hold the feet of the person being studied, an electronics unit and packing with accessories. The equipment makes it possible to record on a digital magnetic recorder the bioelectric activity of the main muscles participating in the maintenance of the body's stability, as well as several parameters characterizing the body's movement during the performance of the given motion.

The "Poza" experiment will make it possible to supplement the results of research in the field of the physiology of motion that have been obtained on Earth and to develop new tests suitable for use in clinical neurophysiology.

Great interest was evoked by the "Ekhografiya" experiment, in which the effect of spaceflight factors on the distribution of blood circulation in the large vessels of the human body was investigated, along with cardiac discharge and volume and the contractile function of the myocardium during the acute period of adaptation, when there is a basic redistribution of the mass of liquid circulating in the upper part of the body. The main attention was focused on studying the blood flow in the vessels supplying the brain.

The method used was ultrasonic echo-sounding and Dopplerography of the heart and the main blood vessels, which made it possible to evaluate the change in the basic indicators characterizing the pumping and contractile functions of the heart, as well as the rate of blood flow in the main vessles and their sizes.

The "Ekhograf" equipment complex was developed by French specialists, whereas the "Pnevmatik" prophylactic complex was developed by Soviet ones. It consists of a set of contractable thigh cuffs for redistributing the blood in the lower extremities. During the flight the experiment was conducted several times, both at rest without the "Pnevmatik" cuffs and during a functional test when they were in use.

Two medical experiments were designed to study different aspects of human vision under spaceflight conditions. The eye's depth perception and resolving power for different levels of illumination were investigated in the "Neptun" experiment. The nature and mechanisms of fatigue of a cosmonaut's visual analyzer in flight were determined in the "Mars" experiments. The essence of the method used consists of equalizing the brightness of the backgrounds of two objects while observing them through a double-refracting prism and a polaroid. Identical brightnesses of the test objects are achieved by changing the angle of rotation of the polaroid. The investigations were carried out with black, green, red and yellow objects. For each investigation, the counter's readings were recorded in the flight log and transmitted to Earth. The level of eye fatiguability was determined from the results obtained by processing this information.

The "Anketa" experiment continued the study of the symptomatology of vestibular disorders in flight and during the readaptation period, as well as the detection of certain relationships in connection with sensitivity to vestibular irritants under

preflight conditions (earlier this experiment was performed by international crews who made orbital flights as part of the "Intercosmos" program). A special list of questions was prepared for "Anketa" and the cosmonauts had to answer them before, during and after a flight. The questions helped the crew concentrate its attention on the dynamics of their own sensations that are related to the development of motion sickness and on the dependence of their appearance on specific flight conditions and the nature of the activity being performed.

The "Microbe Exchange" experiment investigated the "acclimatization" processes of microflora in the body of a new host under conditions of a "cross" exchange of micro-organisms between cosmonauts (the members of the basic and international crews). The purpose of the experiment was to evaluate the sanitary and hygienic situation in the station when it was occupied jointly by the members of two expeditions. The level of microbe reproducibility of the cosmonauts' skin and upper respiratory tracts was determined by taking smears in test tubes and preserving them.

Two experiments were of a biological nature. In the "Bioblok-3" experiment, the effect of heavy charged particles from galactic cosmic rays was investigated. When penetrating a cell, these particles ionize matter with which they come into contact; this can damage the cell's structure and disrupt its functioning. The experiment was performed with the "Bioblok-3" device, which consisted of six separate assemblies (three each built by Soviet and French scientists). The biological objects (plant seeds) were placed in them, together with cosmic particle detectors, in such a fashion that after the information gathered by the detectors was processed, it was possible to determine through which specific object a particle had passed. This processing was done on Earth, after the flight: the plant seeds were allowed to germinate and it was determined whether or not there were any deviations in them by comparing them with control seeds that had remained on Earth.

Different durations of exposure of the biological units on board the station, rang-from a month to a year, were provided. The experiment is being conducted in three stages: after each one, two units--one Soviet and one French--will be returned to Earth. The processing of the flight material will be carried out in laboratories in the Soviet Union and France. The specialists hope to enlarge on their present knowledge about the effect of cosmic rays on biological systems, so that they can evaluate the degree of danger of their effect on biological systems and take the necessary protective measures. This is particularly important during protracted flights into space. The results of the experiment will also be of assistance in solving problems related to the creation of biological life support systems in future orbital stations.

In the "Tsitos-2" biological experiment, the change in the properties of microorganisms under spaceflight conditions was studied, along with their sensitivity to different antibiotics. This is supposed to produce new information about the effect of spaceflight factors--weightlessness, in particular--on the biological properties of a microbe cell, and will be an important contribution to the solution of the problem of preventing and curing possible infectious diseases in cosmonauts during a flight.

The international crew also performed a series of technological experiments. Data on the thermal characteristics of the "Kristall" unit's "Magma-F" furnace were obtained during the "Kalibrovka" experiment. These data are needed to refine the

mathematical model of the furnace's thermal field and determine the convective component of heat transfer in tube furnaces in operation in the closed compartments of orbital stations. The essence of the experiment consisted of measuring the furnace's thermal profile in different operating modes, with simultaneous registration of the accelerations arising along the orbital station's axes.

The "Diffuziya" experiment was performed to determine more precisely the diffusion coefficients of copper in contact with a lead melt at different temperatures. The comparison of the results of the space experiments with those of experiments carried out on Earth will make it possible to evaluate the effect of local convection (in direct proximity to the edge of a solid) on the diffuse transfer of matter in a liquid phase.

The "Likvatsiya" experiment was conducted in order to investigate the coalescence processes (the merging of drops of liquid or bubbles of gas as they come into contact) of granulated indium in an aluminum melt and the crystallization of the granulated (dispersed) structures of immiscible liquid metals at different cooling rates. Under terrestrial conditions it is impossible to create such compounds because of so-called liquation of the elements, which means heterogeneity in the alloy's chemical composition arising during its crystallization. The results of the experiment are interesting from the viewpoint of producing composite materials of a new class that consist of elements with substantially different densities and melting temperatures.

The purpose of the "PIRAMIG" and "PSN" astrophysical experiments was to obtain information about the Earth's atmosphere (the polar auroras, emitting layers in the Earth's atmosphere, noctilucent clouds, lightning, meteors), the interplanetary medium (zodiacal light, Lagrange points, the counteraurora, the ecliptic poles) and galactic and extragalactic sources (the nebula in Orion, the Magellanic Clouds), as well as to photograph new sources (comets and so forth) seen during the period when the experiments were being conducted.

The experiments were performed during the night sections of the orbit, with highly sensitive photographic equipment; during one "orbital night" the objects or phenomena listed above were photographed, with the survey being repeated in several sections of the orbit.

Having fully completed the scientific program for the flight, the international crew returned to Earth on 2 July 1982: the descent vehicle of the "Soyuz T-6" spacecraft, with cosmonauts V.A. Dzhanibekov, A.S. Ivanchenkov and J.-L. Chretien on board, made a soft landing at 1821 hours in the designed area of the Soviet Union, which was about 65 km to the northeast of the city of Arkalyk.

As a result of the flight a large amount of scientific information was obtained that will undoubtedly make a large contribution to the rapidly progressing science of space. As Academician A.P. Aleksandrov, president of the USSR Academy of Sciences, said when he addressed the press conference on 7 July 1982 that was devoted to the results of the flight, "...the flight of the new international crew has become a new summit, crowning years of efforts, and with this summit the scientists of the Soviet Union and France will be able to see the prospects for our cooperation more widely and deeply."

11746
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'DEL'TA' NAVIGATION SYSTEM ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 16 Jul 82 p 2

[Article by B. Konovalov, special correspondent: "'Del'ta--The Cosmonauts' Helper"]

[Text] One of the basic trends in the development of cosmonautics is the desire to increase the independence of spacecraft and gradually reduce the dependence on the Earth of their crews' work. This trend can be traced from "Salyut" to "Salyut." An independent navigation system designed by the Greek letter "Del'ta" operated on an experimental basis in "Salyut-6." In "Salyut-7" this system has already become part of the standard equipment and, for example, when the Soviet-French expedition was working, it was used in such key experiments in the program as "Piramig" and "PSN."

During the Soviet-French flight the shaded parts of the orbit, during which astrophysical photography was carried out, lasted for only 20-25 minutes, and during this brief period it was necessary to photograph certain sections of the sky. In order to do this, Anatoliy Berezovoy and Valentin Lebedev, the hosts on board the "Salyut-7," whose primary responsibility was station orientation during astrophysical experiments, enlisted the aid of an automatic "navigator": the "Del'ta" system. It makes it possible, without help from Earth, to have on board the station complete information about its orbit. It was previously given instructions as to which constellation needed to be studied, and the "Del'ta," independently, with the help of its own computer complex to make the necessary calculations, turned the station in the illuminated part of the orbit so that it entered the shaded section with the instruments already aimed at the proper section of the sky. All that was left for Berezovoy and Lebedev to do was fine manual sighting on previously selected stars. When the surveying was completed, control was again transferred to "Del'ta" and it turned the station so that the instruments could photograph another section of the sky.

In exactly the same way, the "Del'ta" is helping the "Elbrusites" survey the sky with X-ray equipment on board the station. This robot, which externally in no way resembles the automatic heroes of fantastic romances, has essentially become a third member of the crew on board the "Salyut-7." At a postflight press conference, Aleksandr Ivanchenkov told the journalists that "Del'ta" is handling its duties excellently and that the "Elbrusites" are satisfied with its work. Every morning "Del'ta" prints the daily navigational information on "Stroka" teletype tape: entries into and exits from the shade, radio communication time zones, orbital period, passage over the equator and so on.

Wherever possible, "Del'ta" takes on the functions of controlling not only the station's orientation, but also several others, so as to relieve the crew and Earth of routine work and to free time for scientific experiments. For example, "Del'ta" has become a unique dispatcher for the on-board radio engineering complex. Every morning a message from Earth enters in its memory the daily operating program for the radio engineering units and, even further, "Del'ta" acts itself: it predicts the station's motion, turns on the transmitters of the voice and telemetric systems and the command radio link before entry into a radio communication zone, and turns them off after the station exits the zone.

"Del'ta" can also take on the function of controlling scientific equipment, such as the X-ray telescope, during experiments. If the crew notices any interesting phenomenon during instrument or visual observations, all a cosmonaut has to do is press a button and "Del'ta" uses the "Stroka" teletype to print the time of the event and the geographic coordinates at that moment. During the next communication session the cosmonauts can report to Earth: at a point with such-and-such coordinates we saw a forest fire, a dust storm, the birth of a typhoon, an accumulation of plankton or some other phenomenon.

"Right now we are accumulating experience in using 'Del'ta'," says Doctor of Technical Sciences E. Gaushus, one of its developers. "In the future its functions will be expanded. Ideally, the cosmonauts should have to handle only those instruments that are not capable of being automated. From controlling the movement of an automatic unit, we should gradually change over to controlling the station's flight and functioning. It is possible to imagine that Earth will, let's say, assign the work program for the day, and after that the on-board automatic equipment will assume the Flight Control Center's duties. In order to achieve this, of course, it is necessary to simplify human intercourse with a computer and make it easier.

"What we're striving for is that a cosmonaut can use his voice or print, such as a keyboard, instead of a complicated combination of keys and toggle switches, to ask at any time, for example, "How is the heat regulation system working?" and to receive an answer immediately, either lit up on a display screen or in printed form. The problems standing in the way of automating the work done in space complexes are complicated but completely solvable, and in future orbital stations, in my opinion, automatic units will undoubtedly play a larger role than they do now."

"Calling the support crew," we hear over the loudspeakers as the conversation about the "Del'ta" system ends.

"Here we are," answer Lidiya Berezovaya and Lyudmila Lebedeva. "We congratulate you for all your special occasions: two months of work, the arrival of the 'Progress' and Tanechka's birthday."

"For us this is the main occasion: my daughter's eighth birthday," says Anatoliy Berezovoy, the proud papa, from orbit. "Valentin and I wish you luck and health, that you do well in school and obey your mom. Look, Tanechka, this is your picture, and I brought it with me into space. And here's a Young Pioneer's red tie for you, that you'll get when you grow up."

"We printed on it that it's a space tie," adds Lebedev. "Thanks for the messages. We received fresh tomatoes, apples and lemons on the 'Progress-14.' That was so we could celebrate Tat'yana's birthday."
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COMMENTS ON 'SALYUT-7' COSMONAUTS' EVA

Moscow PRAVDA in Russian 31 Jul 82 pp 1, 3

[Article by A. Pokrovskiy, special PRAVDA correspondent: "The Hatch is Thrown Open to the Universe"]

[Text] With congenially outstretched arms, the spacesuit seems to be inviting you to enter. And "enter" is the right word, because this kind of suit, which can justifiably be called an individual space cabin, is not "put on". One enters it through a hatch.

The invitation could indeed be accepted -- another thing about this spacesuit is that it comes in one size that fits all. Its metal "thorax" is spacious, and the soft "arms" and "legs" are fitted with special sections for adjusting to height. Only the gauntlets are screwed into the spacesuit for an individual fit, so that fine work can be done. Nonetheless, I decided not to enter the suit as appropriate training is required, but I did try a gauntlet for size. This structure, whose purpose is to protect the human body from cosmic radiation, vacuum and low temperatures, was soft and manageable -- one could hold a pen and take notes.

Of course, the spacesuits consigned to the Salyut-7 were worn by Anatoliy Berezovoy and Valentin Lebedev while they were still on the earth. These suits of armor were put on many times for training. Just the same, one more dress rehearsal of emergence into open space was needed on board. The slightest error cannot be tolerated in this complicated and responsible operation. Special groups set up at Mission Control naggingly kept track of the astronauts' procedure. And they gave their unanimous decision: "The 'Elbruses' are ready to go out!"

The EVA started in the early morning of 30 July. Arrayed in their spacesuits, A. Berezovoy and V. Lebedev battened down the hatch between the working and passage compartments of the stations. Then it was time for the hatch leading to open space. They had not yet had time to really open the cover when vacuum began to suck at the atmosphere of the passage compartment. The astronauts were experiencing the conditions of outer space without having left the station.

Flight engineer V. Lebedev took the next step gradually: going out onto the surface of the station. At first the astronaut extended himself into the

limitless chasm only to the waist, and then cautiously, secured by his commander A. Berezovoy, he raised himself to his full height above the station. The work specified in the mission program began. While the astronauts are completely absorbed with this, I will hold brief interviews with the ground crew of the experiment.

[Spacesuit specialist]: "A spacesuit of the so-called semirigid type was first used during the Salyut-6 mission. The astronauts wore it in open space many times. The complete reliability of the spacesuit has been confirmed, and at the same time we have found ways to improve it. For example there has been an increase in the length of time that it is worn. We have done this by providing for connecting the life support system of the suit to panels on the station before and after extravehicular activity, thereby extending the autonomous operation of the system. The spacesuit control panel is now more conveniently located on the chest."

[Physician]: "Clearly the well-being of the astronauts is important during such responsible work. Therefore a group has been set up at Mission Control for medical monitoring of extravehicular activity. This group includes specialists well acquainted with the health of A. Berezovoy and V. Lebedev, and prepared to make recommendations on the course of operations in open space. In addition to their spacesuit, the astronauts also wear a medical belt. The sensors on this belt transmit real-time data to the earth on EKG, pulse rate, respiration. We also keep track of temperature conditions. Special coveralls worn under the spacesuit carry fine water lines for temperature regulation. This is done by merely pressing a button on the spacesuit control panel."

[Methodologist]: "Many times together with the crew here on the ground we worked out operations in the spacesuit, which is a 'vacuum bottle' made up of several layers of vacuum-shield insulation. From my own standpoint, I would like to point out another important feature of the spacesuit: it has no outside connecting lines. Supplies of oxygen and water, blowers, pumps and other equipment are accommodated in the cover of the rear hatch. The astronaut cannot accidently snag himself and break some line. There is a safety line terminating in a snap hook by which the flight engineer secures himself to handrails on the surface of the station. An electric line also connects him to the station, so that accidents are eliminated."

...Meantime, Valentin Lebedev has secured himself to a special "anchor" site and gone to work. He takes the "Medusa" device from the surface of the station. This is a set of vials containing simple organic compounds. By studying them before and after the action of space radiation, scientists obtain valuable information on the evolution of molecules under unusual conditions. Lebedev fastens the panel to the line with a snap hook and transfers it to Berezovoy. Watching their actions on the TV monitor, one sees pictures from science fiction stories. And isn't what we are now seeing truly science fiction?

Let us recall that the mission assignment for German Titov included the notations "try to eat", "try to sleep". After all, in the initial conquest of space it was unknown whether even this could be done. Later on, one of the

items on the mission assignment of A. Leonov in 1965 read "go out into open space". Four years later, A. Yeliseyev and Ye. Khrunov had crossed open space from ship to ship.

On Salyut-6, EVA's became common for the main crews, including both routine jobs and non-routine unplanned work as when V. Ryumin freed a docking unit from a snagged antenna. And right now on the surface of the station we see what is essentially installation work: V. Lebedev is partly removing and partly replacing certain devices. This experience will enable development of methods of doing future installation work in outer space. For example the "Pamyat'" device will prompt us on how best to handle thermomechanical joining of pipeline sections in outer space. A coupling of nickel-titanium alloy "remembers" the dimensions that it had at a certain temperature. It can be slipped over the pipes, and then it returns to its former dimensions, tightly joining the pipes by itself without intervention from the outside. The "Resurs" device will provide scientists with data on the behavior of different materials in outer space (stainless steel, titanium alloys and the like) under mechanical stress. The "Istok" will give information on the reliability of threaded connections of different materials. Designers are becoming more and more interested in this kind of connection in planning future installation work in outer space. The same kind of a check is being done on gasket rubber, glass- and carbon-reinforced plastic, insulating coatings, glass for ports and lenses.

V. Lebedev told about all this during the telecast, standing on the station as on a podium. The television camera, which was being controlled during this time by A. Berezovoy, showed us both the surface of the space complex and our blue earth far below.

"I see Balkhash!" comments V. Lebedev.

"And you didn't notice Baykonur?" asks A. Leonov, getting into the act.

"Of course" was the comeback from "Elbrus-2". "I could even make out the hotel where we stayed."

Everything considered, A. Berezovoy and V. Lebedev are in an excellent mood. Naturally after two and a half hours of concentrated work, the astronauts were feeling some fatigue.

"Well, that's okay" they summed up. "In compensation it was interesting." The "Elbrus" Mission was a complete success, and the extravehicular activity threw mankind's hatch to the universe still wider open.

6610
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RATIONALE FOR SELECTION OF FEMALE COSMONAUTS

Moscow PRAVDA in Russian 20 Aug 82 p 3

[Article by V. Gubarev, special correspondent, Zvezdnyy Gorodok, Baykonur, Flight Control Center: "I Like This Work"]

[Excerpt] While Leonid Popov and Valeriy Ryumin were making their long flight in "Salyut-6," women appeared in Zvezdnyy Gorodok. They were cosmonaut candidates, and among them was Svetlana Savitskaya.

I remember how the arguments raged: how, using what criteria, to select women for a flight? The choice turned out to be definitely not a simple one: among those wishing to make a flight were specialists from branches of science and technology, including doctors, astronomers, physicists, specialists in cosmonautics, designers and pilots. To whom to give the nod?

The arguments would probably still be going on today if the director of the Cosmonaut Training Center imeni Yu.A. Gagarin had not arrived at the firm conclusion to make the choice according to the same criteria used for male cosmonauts, without making allowances for "the weaker sex" and without easing the rigorous medical requirements.

Why had the time come to "return women to cosmonautics," as one of the designers asked? Various opinions have been expressed. The doctors think that it is time to study carefully the special features of the female body's reaction to weightlessness. Some specialists at the Training Center are convinced that mixed crews train more carefully (in connection with this, Viktor Savinykh noted, "When a woman is next to you, you simply do not have the right to work half-heartedly!") Analyzing the results of the training for the flight of Savitskaya and her backup, the methodologists say that for some of the work on board the station that requires carefulness and accuracy, women are capable of acting more efficiently than men. All of this is so, but there is yet another weighty reason. Working conditions on board the Soviet "Salyut"-"Soyuz" complex have become much more comfortable than on the "Vostok" ships, when Valentina Tereshkova flew. A further goal in the conquest of space is the creation on board of conditions that maximally approximate terrestrial ones. Women today have mastered the most variegated professions that were recently considered purely masculine ones, and Svetlana Savitskaya says that sometimes they do better than many men. There is no basis for doubting that it will be the same in cosmonautics.

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POPOV, SEREBROV, SAVITSKAYA POSTFLIGHT NEWS CONFERENCE

Moscow IZVESTIYA in Russian 3 Sep 82 p 2

[TASS article: "Report on the Watch in Space"]

[Text] Yet another working expedition has been completed in orbit. The flight of the second crew to visit the "Salyut-7" orbital station evoked animated responses throughout the world, and not only because a female cosmonaut participated in it. Authorities in world science and technology know that, from launch to launch, the Soviet space program is demonstrating huge capabilities for studying the Universe and the Earth, and that is why the results of this peaceful storming of space are of global interest.

The working report of cosmonauts L. Popov, A. Serebrov and S. Savitskaya on their mission was again convincing proof of this. The press conference for the crew, which was held at the USSR MID [Ministry of Foreign Affairs] on 2 September, was attended by representatives of the leading Soviet and foreign newspapers and news agencies and radio, television and magazine correspondents. The leaders of the Cosmonaut Training Center and the Flight Control Center, as well as prominent Soviet scientists and specialists, also came to the meeting.

The press conference was opened by Yu. Chernyakov, chief of the USSR MID's Press Department. He then ceded the floor to Academician O. Gazenko, director of the Institute of Medicobiological Problems.

"First of all," said the scientist, "allow me to greet our cosmonauts--Leonid Popov, Aleksandr Serebrov and Svetlana Savitskaya--and congratulate them upon their successful completion of the flight program and the high awards their homeland has conferred upon them.

"The scientific experiments and investigations that were conducted during the flight can be grouped into three areas: geophysics and astrophysics, biotechnology, and medicine.

"The 'Piramig' and 'PCN' cameras, which were developed and manufactured in France, were used to conduct atmospheric research during which the cosmonauts observed the polar auroras, luminescence in the upper atmosphere and noctilucent clouds. A number of experiments were related to observing the luminescence of the interplanetary dust and studying astronomical objects beyond the limits of the Solar System--clouds and galaxies--with primary emphasis on their peripheral areas, which have low

surface brightnesses. Using an electrophotometer that was manufactured in Czechoslovakia, the cosmonauts studied the optical properties of the Earth's atmosphere.

"I, as a doctor, would like to dwell in more detail on the 'Tavriya' bioengineering experiment. On the 'Salyut' orbital stations the cosmonauts have always conducted research aimed at studying the behavior of liquids and metals, plastics and other compounds under weightless conditions. There is also an extremely tempting and seemingly promising possibility of obtaining several superpure, biologically active substances--enzymes, hormones, antibiotics--under space conditions for use on Earth for medical purposes. This was the purpose of the 'Tavriya' experiment. It was confirmed that under weightless conditions the speed of the process of matter fissioning increases and the actual degree of purity increases many times.

"As always on short flights," emphasized O. Gazenko, "we gave very close attention to the study of the cardiovascular system and the vestibular apparatus, since those are the main 'target' of the effect of weightlessness during the first few days a person is in space. During the active sections of the flight--during the launch and just before the landing--a regular increase in the frequency of the crew members' cardiac contractions was observed. I would like to call attention to the fact that, as a rule, the degree to which this reaction of the human body is expressed smooths out during repeated flights. For the crew commander, who was making his third flight into space, the maximum pulse rate during the launch was about 80 beats per minute, whereas on his first flight it was about 100 beats per minute.

"In addition to investigations into the nature of the functional changes in the body, the cosmonauts also tested means for preventing the unpleasant effect of weightlessness on the human body. In connection with this, they used elastic, contractable 'bracelet' cuffs that cause blood to be deposited in the leg vessels and a special device, called the 'collar,' that exerts a certain amount of pressure on the neck muscles and limits the movement of the head. With the help of this device it is possible to reduce the effect on the vestibular apparatus, which in the final account reduces the probability of the appearance of 'motion sickness.'

"An important conclusion to be drawn from this flight is that the doctors did not detect any substantial differences in the reactions of the male and female bodies to the conditions of spaceflight. This enables us to view optimistically the participation of women in future flights into space.

"In conclusion, a few words about Anatoliy Berezovoy and Valentin Lebedev, the basic crew of the 'Salyut-7.' They were of great assistance in the work of the visiting expedition's cosmonauts and were extremely hospitable hosts. They have been working in space for 112 days and have done a large amount of work, but still retain their high fitness for work."

USSR Pilot-Cosmonaut L. Popov, the crew commander, steps forward. "Upon me fell the honor," he says, "to lead this crew, which consisted of Flight Engineer A. Serebrov and Cosmonaut-Researcher S. Savitskaya, the second woman in the world to make a flight into space. As with the preceding ones, the duration of our visiting expedition was not long--only eight days. However, its program was notable for the large amount of work that was done: a broad circle of scientific, technical and medicobiological experiments were performed with the collaboration of A. Berezovoy and V. Lebedev."

The crew commander told the journalists about the preparations for the flight and some of the experiments that were performed during the expedition. "I had to work in the 'Salyut-6' station," he mentioned further. "Although the basic parameters of the 'Salyut-7' station were the same, it was much easier to work in it.

"Throughout our entire stay in the station," noted L. Popov, "our relationships were characterized by friendliness and complete mutual understanding. We wanted to stay with the main crew very much, but the planned program was carried out. We returned in the 'Soyuz T-5' ship of our 'hosts' in the station. It had already been in space for more than 100 days.

"The first flight with a mixed crew has been completed," L. Popov said in conclusion. "We believe it will not be the last and we're already hearing about new spacecraft flights that will have women in their crews. We hope that the results of our flight will be used in the preparation of new programs for space research. We were particularly happy that this flight was made on the eve of a notable date: the 60th anniversary of the founding of the USSR."

"I, as the flight engineer," said A. Serebrov when it was his turn, "would like first of all to mention the reliability of Soviet space equipment, which is the foundation of our latest achievements." Having described the capabilities of ships of the "Soyuz T" series and the "Salyut-7" station, he mentioned that almost all the on-board experiments were of an applied nature. This applied particularly to the tests and investigations aimed at improving space technology.

In speaking about Svetlana Savitskaya's participation in the performance of the experiments, the flight engineer emphasized that during the course of them the crew had to carry out many complicated operations that were frequently irreversible. An error in any one of them could affect the success of the entire experiment. Svetlana performed them flawlessly. The formulators of the experiments had counted on her accuracy and attentiveness. In planning for the observation of fine color images--twilight phenomena, the colors of the Earth's horizon--they had taken into consideration the "woman's eye for things." At the same time, the female pilot's experience in identifying local reference points also proved valuable.

"The 'Salyut' stations," A. Serebrov added, "can be compared to reliable 'row' houses in space. Figuratively speaking, however, they are the first tents in the virgin expanses of space. And the trail-blazing explorers working in them are nearing the time of space cities and factories, the 'settlements in the ether' about which K.E. Tsiolkovskiy dreamed."

The journalists greeted S. Savitskaya warmly. "During the flight on the station," she said, "we carried out more than 20 different investigations and experiments, and we did most of them several times."

This cosmonaut spoke with enthusiasm about the astrophysical part of the program, in particular about the observations made with the French "Piramig" and "PCN" instruments. During these experiments, invaluable assistance was given them by Anatoliy Berezovoy and Valentin Lebedev, the crew of the main expedition. They know the station well and control it excellently.

Dwelling on the medical experiments, S. Savitskaya emphasized that she performed them with great pleasure. "Throughout the entire flight," she declared, "the other

members of the crew and I felt good. I think that the techniques for training crews and the experience that we have now accumulated guarantees cosmonauts a smooth encounter with weightlessness. In addition, on board there are a number of effective prophylactic facilities that make the acute period of adaptation easier and make it possible to return to Earth without any damage to one's health. Our commander said that we worked harmoniously and found a common language. I share this opinion completely. The work was very pleasant and there was a warm, friently atmosphere. We worked enthusiastically and joked a lot. The fellows were concerned about me and I about them. I would like to thank the main crew very much. They greeted us so warmly, prepared the station for our work remarkably well, and helped us in everything."

The cosmonauts and scientists then answered the journalists' questions.

The correspondents were interested in how the preparations for the Soviet-Indian manned flight are going. Lieutenant General of Aviation G. Beregovoy reported that from the numerous candidates in Indian, four aspirants for the flight have been chosen. Two of them will come to Zvezdnyy Gorodok for training in September or October.

To the question of whether or not there will be more crews visiting the "Salyut-7," G. Beregovoy answered that at the present time no such launches are being planned.

11746
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'SALYUT-7' COSMONAUTS PASS 5-MONTH MARK IN ORBIT

Moscow IZVESTIYA in Russian 13 Oct 82 p 3

[Article by B. Konovalov, special correspondent: "Five Months in Orbit"]

[Text] The space odyssey of the "Elbrusites" began on 13 May. Their flight has already lasted 5 months. Behind them are 110 million km of starry road, the reception of 2 guest expeditions and 3 "Progress" cargo ships, a spacewalk and hundreds of completed scientific experiments. When the 151st day of the flight of Anatoliy Berezovoy and Valentin Lebedev arrived, the head of the Flight Control Center arranged a unique "round table" for journalists so that specialists could present some of the results of the "Elbrusites'" 5 months' worth of work.

"Berezovoy and Lebedev, who have begun working in 'Salyut-7,' have already passed the durations of the flights of the first and second main expeditions in 'Salyut-6' and are approaching that of the third expedition," remarked Deputy Flight Controller V.D. Blagov. "Each of the 'Progress' ships unloaded by the 'Elbrusites' delivered about 1,200 kg of dry cargo and 700 kg of fuel. Thanks to these 'trucks,' the scientific equipment is being renewed and supplemented all the time.

"In all fields of scientific research--astrophysics, geophysics, space technology, medicine, biology and technological experiments--the work is proceeding successfully and fruitfully. The 'Elbrusites' have also made a large number of visual observations.

"The Flight Control Center is satisfied with the crew and Berezovoy's and Lebedev's fitness for work remains high. Some fatigue has been seen, but it is of an up-and-down nature. Fatigue 'peaks' hit during docking and the spacewalk, whereas the largest 'burst' is produced by visiting expeditions. However, everyone knows this from terrestrial practice. After the guests leave, the host is always tired. On the whole, however, the 'Elbrusites' feel good."

"Five months is the length of a full-scale geological expedition," continues V.V. Kozlov, chief geologist of the All-Union "Aerogeologiya" association. "And we understand how the crew feels now and how it's acting. On our expeditions valuable finds frequently occur at the end of the season, when the geological party knows the region quite well.

"The same thing is now happening with the geological expedition in space. We see that the 'Elbrusites' have already gotten used to observations for geology: they

orient themselves on areas quite freely and recognize different regions quite easily. In addition, the information we receive from them is becoming more and more valuable.

"The visiting expeditions have already brought us 15 pages of maps with geological observation notes from the 'Salyut-7,' along with several photographs, processed on board by the crew, where the cosmonauts noted objects that attracted their attention. On the other hand, on an operational basis we have obtained a large amount of information with the help of the 'Niva' unit, which records a panorama of the Earth on a videotape recorder in the station and transmits it to the Flight Control Center. Because of this, geologists were able for the first time to look at the Earth as if from the eyes of the crew on a real time scale and imagine what their work is like. The crew has shown us extensive areas in the southern USSR, from the Volga to the Altay Mountains. During this transmission Berezovoy and Lebedev gave us a running commentary on how they were seeing faults and other geological formations. The crew's capabilities are now clear to us and we have received a large amount of interesting information.

"Right now we are making an operational analysis of all the information we have received from 'Salyut-7.' On the one hand, the data will be taken into consideration when planning further geological work, and on the other we have tried to make an immediate operational check of the results in a number of regions: the lower Volga, the pre-Caspian area, central Kazakhstan and the central part of the Baykal-Amur Main Line. We expect to discover new ore deposits. It will be very interesting to investigate the previously unknown sloping uplifts discovered by the cosmonauts, because gas and oil deposits can be related to them."

"Astrophysical research on board the 'Salyut-7' is being conducted primarily in the X-ray band," says Ye.K. Sheffer, senior scientific associate at the State Astronomical Institute imeni P.K. Shternberg, continuing the conversation. "A whole series of interesting results has already been obtained. For example, they have recorded a powerful burst of X-ray radiation from one of the so-called Seyfert galaxies, which are distinguished by active nuclei. The X-ray flare lasted for 12 hours and the radiation's brightness exceeded the normal average level of this galaxy's X-ray radiation by a factor of 30. Thanks to the fact that a whole series of ground observatories in the Soviet Union and other countries are observing the sky according to a program coordinated with the space experiments, 40 days after the burst of X-ray radiation terrestrial telescopes registered a burst of radiation from this galaxy in the optical band that lasted 15 days. The brightness of the galaxy's luminescence increased by a whole stellar magnitude. These data confirmed the opinion of astrophysicists that the flare was born in the nucleus of the galaxy, from which the X-ray radiation comes. The change in brightness in the optical band is related to the interaction of the X-ray radiation with the nucleus's gaseous shell. Right now the radio astronomers are keeping watch. In this band the flare will tell us about itself with a greater time lag. Thanks to the unique observations made on board the 'Salyut-7,' we can now follow all phases of the activity of a Seyfert galaxy."

"The results of careful medical observations," concludes Doctor of Medical Sciences I.I. Kas'yan, "indicate objectively that the state of Berezovoy's and Lebedev's bodies is normal and no substantial deviations in the functioning of the basic systems has been observed. The prognosis for the future is favorable. The flight can continue."

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BEREZOVOY AND LEBEDEV COMMENT ON 5 MONTHS IN SPACE

Moscow PRAVDA in Russian 13 Oct 82 p 3

[Article by V. Gubarev, special correspondent, Flight Control Center: "Five Months Into the Flight"]

[Text] The appearance of the little mouse was unexpected. Anatoliy and Valentin were busy at Panel No 1, orienting the orbital station complex. Unexpectedly, directly in front of them they see...a mouse. It was near the far blower. Sharp little snout, long tail...The cosmonauts froze from the unexpectedness: they had seen nothing like this during the flight.

"Could it be that they sent it up in the 'truck'?" Berezovoy broke the silence.

"There's nothing about it in the inventory," objected Lebedev.

Berezovoy turned off the lamp and the mouse disappeared. And then the cosmonauts broke out laughing: they understood the secret of the appearance of the space mouse! No, they had not started hallucinating, nor had they discovered the next surprise from the people on the ground (who, by the way, had done pretty well along that line by sending the fifteenth cargo ship to the 'Salyut-7'--it contained pleasant and unexpected gifts for Berezovoy and Lebedev). An ordinary napkin had played a funny joke on these long-time inhabitants of space. It fell into the blower, was squeezed into a ball, had some of its threads unravel and, when illuminated by the lamp, looked like a mouse.

"It's easy to understand our bewilderment," Anatoliy Berezovoy laughs, talking about this episode. "We know this station by heart and can find anything with our eyes closed, so the appearance of a space mouse startled us so..."

"It's like a puppet show," adds Valentin Lebedev. "The unforeseen doesn't happen to us, and then something new..."

"By the way, don't forget that we need a minimum of three days to describe all our belongings," says Berezovoy, returning to the daily routine.

For the first time, perhaps, I have heard the crew talking about returning to Earth. And although there is still time before the planned end of the expedition, the "Elbrusites" know quite well that the Future Planning Group at the Flight Control Center, which for all these months of A. Berezovoy's and V. Lebedev's space watch

has been refining and adding details to their work schedule for many weeks in advance, has already started planning the end of the expedition.

"Do you miss home?" I ask.

"Even when you go on a mission for several days, you miss it," answers Berezovoy, "and we haven't seen our loved ones for a good half a year already."

"And how's the weather," Lebedev wants to know.

This question is heard from space every day. As soon as the "Elbrusites" start communicating with the duty watch, they report briefly about how they feel and the status of the on-board systems and then come out with the traditional "How's the weather?"

"It's not spoiling us," answers the operator. "It's drizzling. And it's cold."

"We're warm and dry," Valentin laughs.

"But today you're going to get a little wet," responds the operator, "because it's bath day..."

"Oh, what we need is a bunch of birch branches up here..."

"Take the service information," the operator glances at the day's program. "Did you get the data on the undocking of the 'truck'?"

"Everything normal, nothing to worry about," says Berezovoy.

Before allowing me to talk, the operator gives the data needed for the work to be done during the next two revolutions. They are "deaf" ones; that is, there will be no communication with the crew. During these hours the orbital complex will cross the Indian and Pacific Oceans and pass over North America. Even this communication session is not very long--it is being provided by the scientific research ship "Kosmonavt Vladimir Komarov," which is in the North Atlantic. So I hurry to ask Valentin and Anatoliy the question that has already become a tradition in these monthly conversations: "How do you, yourselves, evaluate your work for the past month?"

"Unfortunately, we didn't have any guests," jokes Berezovoy. "Although both crews--both the Soviet-French one and the mixed one--have not forgotten us. It was pleasant to meet (Jean-Loup Chretien) again, and Svetlana Savitskaya and...well...with all the folks that have been in 'Salyut-7.' But no matter how pleasant these radio meetings are, all the same to open a hatch behind which are three friends is much nicer...In the last month we did a lot of interesting work with 'Progress-15.' It not only brought fuel up to the complex, but also carried equipment that we have already put into position in the station. Now almost all the work with the 'truck' is completed, the compartment is filled with trash, and all that's left to do is see it off. We continued our astrophysical observations, performed biological experiments and conducted technical tests, without forgetting about medicine."

"Well, how about the flight engineer's opinion?"

"We earn our bread," remarks Lebedev, "and of this I was convinced once again not long ago. Specialists came to us--over the radio, I mean," declares Valentin more precisely, "and geologists in particular. They told us that the observations we had made had, in essence, changed the work of five geological parties. The data that we sent them about faults in the area of Lake Balkhash and the northern part of the Aral Sea proved to be very interesting. Those place are very promising as far as useful minerals are concerned. We also talked with astrophysicists. They reported that we taken on the role of forecasters, because we warned them about the possibility of a flare from one of the sources in the X-ray band. The astrophysicists who made use of this information from space succeeded in carrying out careful investigations of this very source. There are a lot of similar examples. You understand that such news helps us a lot and stimulates our work, because we want to be even more successful."

"This is the special feature of long flights," says Anatoliy Berezevoy. "There is an intensive exchange of information between the station's crew and the specialists. In the course of the research much is made clearer and the cosmonauts are able to find out, on a timely basis, how efficiently and with what quality they are conducting an experiment. Now the specialists have started to come to the Flight Control Center even more often, which means that their interest in our work has increased."

"How did you celebrate the space jubilee?" I ask.

"It was a very exciting day," answers Berezovoy. "We celebrated it as heartily as if we had been the ones to launch the first Earth satellite...and it's quite pleasant to complete the first quarter century of the space era in orbit and to begin a new one..."

"It's almost too much to believe that 25 years have passed since the launching of the first artificial Earth satellite," Valentin Lebedev adds to his commander's remarks. "And from here, from space, one somehow feels more deeply how rapidly cosmonautics is developing. The road from the first satellite to extremely complicated orbital complexes--isn't that something fabulous?"

It actually is fabulous. As is the fact that two men have been working above our planet for five months now and are working just as selflessly and inspiredly as in May, when their expedition began. By the way, it is precisely because such people as Anatoliy Berezovoy and Valentin Lebedev have dedicated themselves to cosmonautics that it is being developed so rapidly.

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RYUMIN COMMENTS ON FLIGHT OF 'SALYUT-7'

Moscow PRAVDA in Russian 26 Dec 82 p 2

[Article by V. Ryumin, flight director, USSR pilot-cosmonaut, twice-awarded Hero of the Soviet Union: "Expedition in 'Salyut-7'"]

> [Text] The results of the lengthy expedition by A. Berezovoy and V. Lebedev aboard the "Salyut-7" orbiting station are a worthy gift from the cosmonauts to the 60th anniversary of the USSR's formation. The expedition once again demonstrated the high level of development of Soviet science and technology and the dependability of all units that had supported this flight. Berezovoy and Lebedev established a new record for presence of man in outer space--211 days, displaying courage and heroism in this effort. The expedition became a serious trial for personnel of the Flight Control Center and for land-based and ship-borne resources of the command and monitoring complex.

Outwardly "Salyut-7" resembles its predecessor, "Salyut-6." But many of its systems underwent significant improvements--the result of generalizing the experience of almost 5 years of operation of "Salyut-6." Improvements were made on almost all systems, and they were directed at increasing reliability, expanding the possibilities of automating control, creating more-comfortable conditions for the crew and expanding the program of scientific research.

A. Berezovoy and V. Lebedev took off aboard "Soyuz T-5" on 13 May, and after docking with the station, they transferred into it.

The period of the crew's adaptation to weightlessness proceeded without noticeable complications, making it possible for the cosmonauts to begin active work in their first days aboard the station. Of course, they did experience certain difficulties. No matter how well a person prepares himself on earth, the unusual situation of outer space makes its impression upon his actions, especially in the first few days; moreover the ground control service needs time to work out coordination with the specific crew.

The crew began making visual observations from the very first day of flight. At first this entailed "familiarizing" themselves with earth from outer space

and accumulating information to be used later on. But gradually the crew began working on the tasks posed to it by specialists before it took off. Each previous crew laid emphasis on some particular research direction. Berezovoy and Lebedev began with geological studies. Dozens of messages were transmitted from outer space to geologists, and the latter used this information to confirm data acquired on a certain deposit by ground exploration. Work was also immediately started in other research directions.

Soon after the crew reached the station, it was able to dock with a "Progress" craft and unload it. Thus, in the first phase the crew made the station completely habitable, adapted itself to weightlessness, learned to control the most various apparatus and made preparations to receive the Franco-Soviet crew. Here again there were certain unique features. First of all five cosmonauts had to live and work aboard the station together, and they had to complete a very complex scientific program of the visiting expedition. Berezovoy and Lebedev had to assume the responsibility of imparting the necessary orientation to the station and to minimize consumption of power during docking and transfer. This is why they worked out and tested the procedures beforehand, during their preparations to receive the Franco-Soviet crew.

On 24 June "Soyuz T-6" took off with V. Dzhanibekov, A. Ivanchenkov and J.-L. Chretien aboard, and on the following day the joint crew began fulfilling a program of scientific research. A number of very interesting experiments were conducted. Let me dwell on a few of them.

French specialists created the instruments "Piramig" and "PCN" to study astrophysical bodies, the interstellar and interplanetary environments and the upper layers of the atmosphere. A number of photographs were taken from aboard "Salyut-7," providing interesting data. For example photographs of the Andromeda nebula taken with various filters revealed that the axes of symmetry of images taken with red, blue and green filters do not coincide. It would have been impossible to acquire these data by means of instruments in earth atmosphere. The cosmonauts obtained interesting information on polarization of particles in the interplanetary environment in the red portion of the spectrum.

In the medical research program, besides the experiments performed in previous flights, the cosmonauts prepared and performed a cardiac echograph experiment, and the "Poza" experiment studying the unique ways in which man moves in weightlessness. Industrial production experiments were conducted with the new "Kristall-Magma F" electric furnace. As a result of intense work on the joint 7-day program, all of the planned projects were completed and the crew returned safely to earth.

For almost the next 2 months prior to arrival of the second visiting expedition, the main crew worked on the scientific program, and it received and unloaded another "Progress" craft and performed extravehicular activity. During this operation the flight engineer floated out of the station's transfer compartment and settled himself down on a special device that secures the cosmonaut's legs. Meanwhile the commander received scientific apparatus from him and handed it up to him, conducted a television transmission and took motion pictures. Lebedev removed samples that had been secured to the station's outer hull while still back on earth, he tested a special tool intended for installation and assembly

jobs outside the craft, he inspected the outer surface of the station, and he installed new apparatus. In terms of the time of extravehicular activity--2 hours 33 minutes--this was the longest space walk performed by Soviet cosmonauts.

On 19 August the "Soyuz T-7" took off, piloted by L. Popov, A. Serebrov and S. Savitskaya. The world's second woman in space handled her responsibilities excellently, demonstrating outstanding knowledge of the equipment and an ability to adapt quickly to work in orbit. The visiting crew had its own program of experiments. The most interesting and promising in my opinion was the "Tavriya" experiment associated with biological technology. The object was to confirm whether or not the effectiveness of purification and separation of biologically active substances rises in weightlessness. These were the first experiments on obtaining ultrapure substances of biological origin such as cells, proteins, amino acids and enzymes required by medicine, agriculture and other fields of knowledge.

The experiment confirmed growth in purity of biological substances in weightlessness by a factor of about 10 in comparison with processes conducted on the ground. The rate and productivity of the process was high, 100-fold higher in relation to some substances. One of the most important human proteins (albumin) was divided into five different components under weightless conditions using two different methods. This was an unexpected result. The next thing to do is to create an industrial facility and deliver it into space. The "Tavriya" experiment was continued by the main crew after a "Progress" craft delivered new raw materials.

After the mixed crew left, Berezovoy and Lebedev spent the rest of the flight on their own, and this was more than 100 days. In that time they completed a large part of their research program, and they received and unloaded another two "Progress" crafts. From a psychological standpoint, in my opinion this was the most difficult segment of the flight, but the crew endured it smoothly, with a good work attitude, in close contact with ground control personnel. The psychological support group constantly helped the crew: It organized meetings with their families, friends and artists, but they still had to fly alone, and Anatoliy and Valentin honorably endured their trial of loneliness and confinement.

The total number of experiments conducted aboard the station during the time of the main crew's presence was about 300. I would like to note that throughout the entire flight the success of the crew's intricate dynamic maneuvers was in many ways the product of an onboard computer contained in the "Del'ta" system. While aboard "Salyut-6" this system was experimental and concerned itself mainly with problems associated with ballistic support, aboard "Salyut-7" the "Del'ta" system was used to the maximum, relieving the crew of a number of complex operations, aiming apparatus at particular emission sources, maintaining the necessary orientation or scanning a given region of outer space.

Let me recall another interesting experiment conducted aboard with the help of the "Argument" apparatus. This is the counterpart of the French "Echograph." "Argument" can evaluate the state of the heart's valve apparatus, measure the thickness of the muscle of the left ventricle and septum, determine the diameter of the heart chambers and calculate the volume of heart cavities. But while the

"Echograph" system produces information in the form of individual photographs, the "Argument" apparatus transmits a television image back to earth, where highly qualified specialists can analyze the work of the heart in an unhurried examination. I think that the future of onboard medical apparatus lies with instruments of this class.

Research on the upper atmosphere was conducted aboard with the Czechoslovak electron photometer EFO-1 intended to measure change in brilliance of celestial bodies at the time of their passage beyond the atmosphere and the earth's horizon. The first interesting results have already been obtained. A new apparatus, the "Korund," was used in addition to the well known "Kristall" apparatus to grow monocrystals and to study the course of volumetric and directed crystallization. The "Korund" can perform a series of experiments without human participation by feeding a program into a computer that controls the production process.

It would be impossible to enumerate all of the experiments and the apparatus employed within the scope of this article. All the more so because specialists and the crew still have a considerable amount of meticulous work to do to process the results. And although the flight had ended, the crew, which is participating in the processing of the results, is in a sense continuing its historically unprecedented expedition.

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CSO: 1866/48

NEW ACHIEVEMENTS IN SPACE RESEARCH

Moscow ZEMLYA I VSELENNAYA in Russian No 6, Nov-Dec 82 pp 4-10

[Unsigned article]

[Text] This article was prepared by the editorial staff on the basis of a report presented by Academician V. A. Kotel'nikov, vice president, USSR Academy of Sciences, on 12 April 1982 at a solemn session devoted to Cosmonautics Day.

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In September 1982 we marked the 125th anniversary of the birth of the Russian scientific genius K. E. Tsiolkovskiy, who laid the theoretical basis of cosmonautics. This same year marked the 25th anniversary of the launching of the first artificial earth satellite, the beginning of the practical mastery of space, with Academicians S. P. Korolev and M. V. Keldysh playing the key roles in this work. The distance which we have covered during these 25 years is enormous. We owe our successes to workers, engineers, technicians, scientists and cosmonauts, working under the direction of our Party in the name of progress and peace. During recent years there has been a significant expansion in the sphere of scientific investigations using space vehicles.

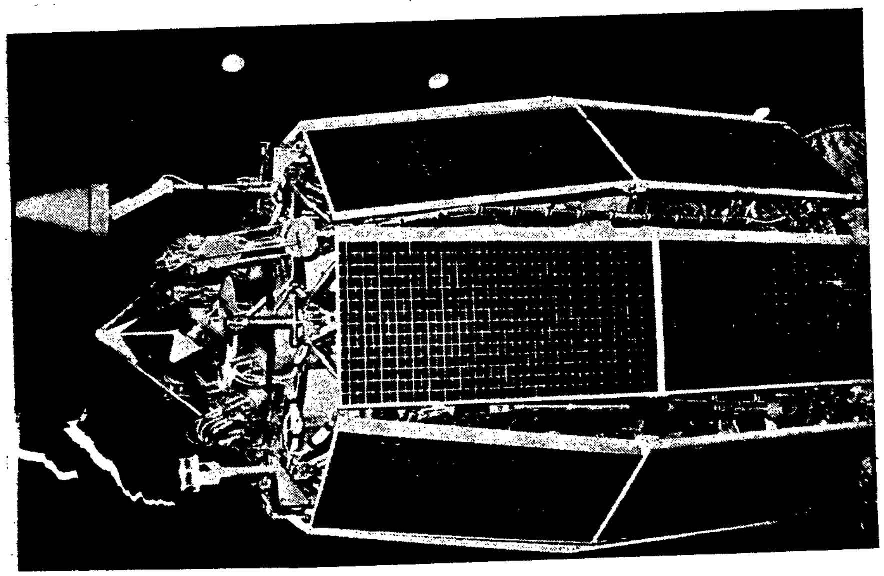
We will discuss recent events transpiring in the space research field. During the past year work was completed on a major cycle of manned space flights in the "Salyut-6" under the "Intercosmos" program with the participation of cosmonauts of the socialist countries (ZEMLYA I VSELENNAYA, No 2, pp 14-35, 1982 -- Editor). In March of this year Soviet automatic space stations flew to Venus; descent modules were separated from them which safely attained the surface and sent us highly valuable data on the atmosphere and ground of this still mysterious planet (ZEMLYA I VSELENNAYA, No 4, pp 4-6, 1982; No 5, pp 19-25 -- Editor).

Complex investigations of the earth's magnetosphere and the upper layers of the atmosphere were continued in 1981-1982 using the international satellites "Intercosmos-Bolgariya 1300" and "Oreol-3" (USSR, France).

In November 1981 the Indian satellite "Bhaskara-2" was launched by a Soviet carrier-rocket for studying the natural resources of India.

The "Salyut-7" station, an improved variant of orbital scientific stations of the second generation, was put into a circumterrestrial orbit on 19 April 1982. The "Salyut-6" was the first station of this generation.

On 13 May 1982 the "Soyuz T-5" spaceship was sent to the "Salyut-7" station; it was manned by A. N. Berezov and V. V. Lebedev. The ship docked with the station and the work of the manned scientific research complex "Salyut-7" - "Soyuz T-5" began in space. Soon the cosmonauts had a rendezvous with the "Progress-13" freight transport ship.

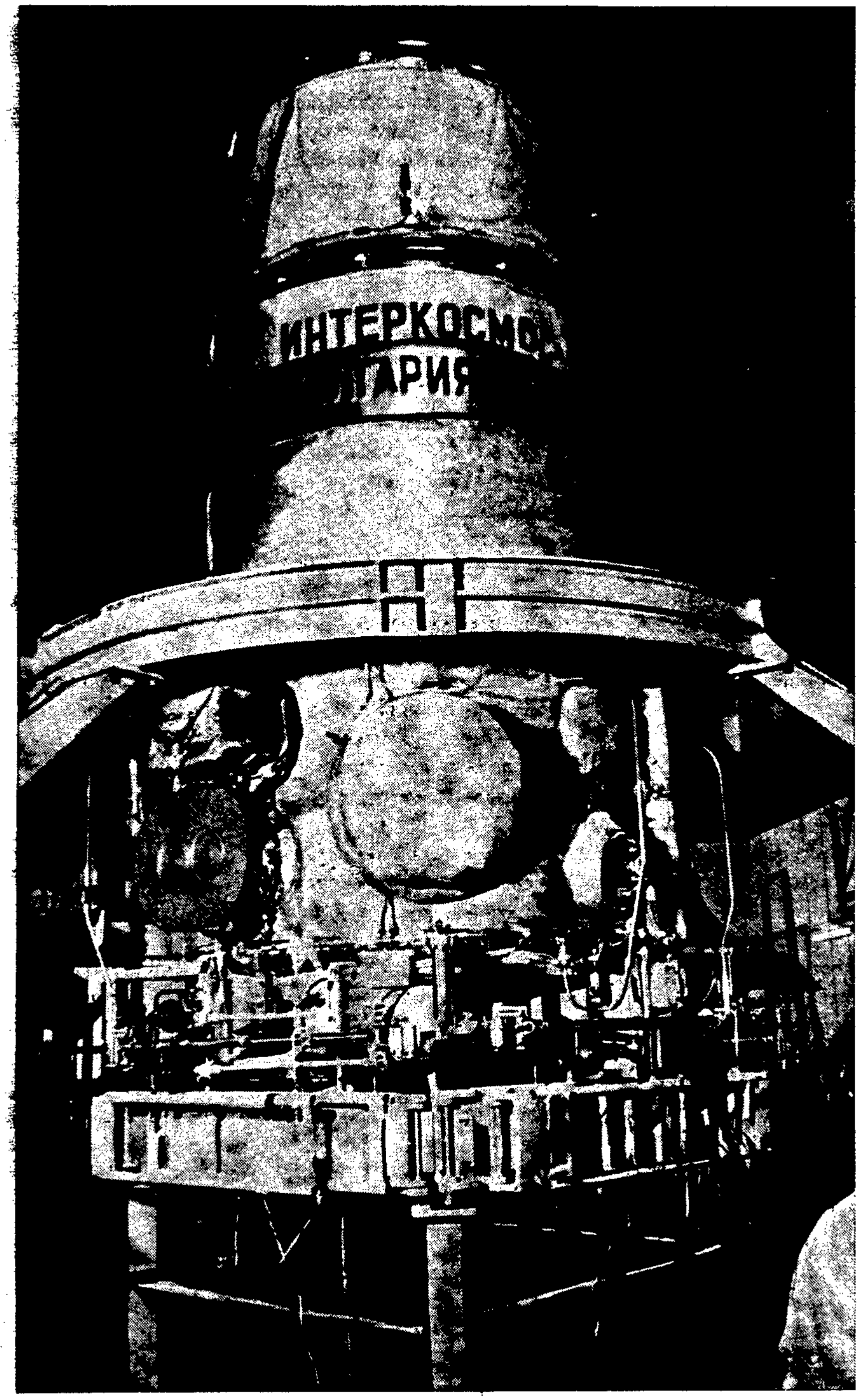


Artificial earth satellite "Oreol-3."

Then, on 24 June 1982 the "Soyuz T-6" transport ship with an international crew aboard was launched into space. The spaceship was piloted by commander V. A. Dzhanibekov, ship's engineer A. S. Ivanchenkov and cosmonaut-researcher Jean-Loup Chretien, a French citizen.

The scientific program for the flight of the Soviet-French international crew included 14 experiments in the field of space biology and medicine, astrophysics and study of materials in space. These experiments are among the most important directions in space research. Their timeliness and significance for the further development of cosmonautics, fundamental and applied sciences is beyond question. The cosmonauts have brilliantly dealt with the tasks assigned them and on 2 July, after successful implementation of the program, returned to the earth.

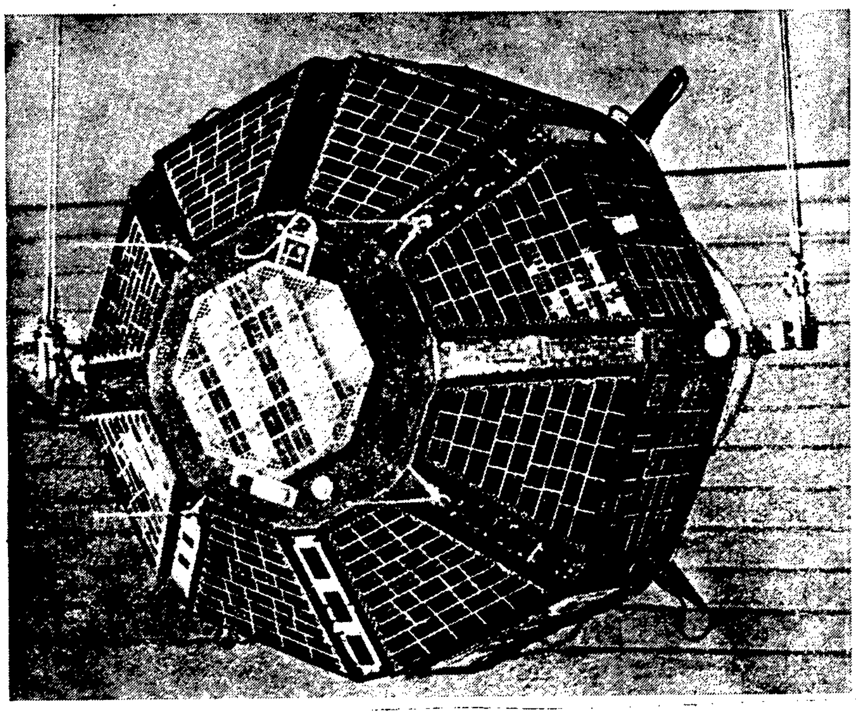
The flight of the Soviet-French crew was the net result of many years of productive cooperation between our countries in the study and mastery of space for peaceful purposes and at the same time afforded new possibilities for cooperation in this field. During 16 years of joint work in space Soviet and French satellites have obtained many valuable results which have won wide recognition from the world scientific community. It is therefore natural that over the course of many years Soviet-French cooperation in space has been characterized as exemplary.



"Intercosmos - Bolgariya 1300" artificial earth satellite.

On the initiative of our scientists an international program is now being intensively developed for investigating Halley's comet, a meeting with which will occur in 1986 (similar approaches occur approximately once in 76 years). Plans

call for directing a Soviet space station to the comet. It is planned that the station will be outfitted with scientific instrumentation constructed in many countries.



"Bhaskara-2" artificial earth satellite.

There have been improvements in communication and TV broadcasting via satellite; systems for observation of the earth from space for study of the earth's resources, the status of sown areas and forests, for contending with forest fires and for compiling weather forecasts have been developed; satellite navigation systems have been improved.

On the basis of space research it was possible to create a new, refined theory of the motion of planets of the solar system, which is very important for the navigation of space vehicles. Thus, many important events have recently occurred in space research. Our country, as before, occupies a leading place in this field.

Mention should also be made of what in my opinion are the most significant achievements in space in the West. For example, the multistage "Ariane" rocket has been created through the joint efforts of the Western European countries. This rocket was used in putting several earth satellites with scientific instrumentation into orbit. The United States launched space stations and photographed Jupiter and Saturn from a close distance. In addition, the United States carried out the first launchings of the returnable "Columbia" spaceship

into an earth satellite orbit, expending great efforts and resources on its creation.

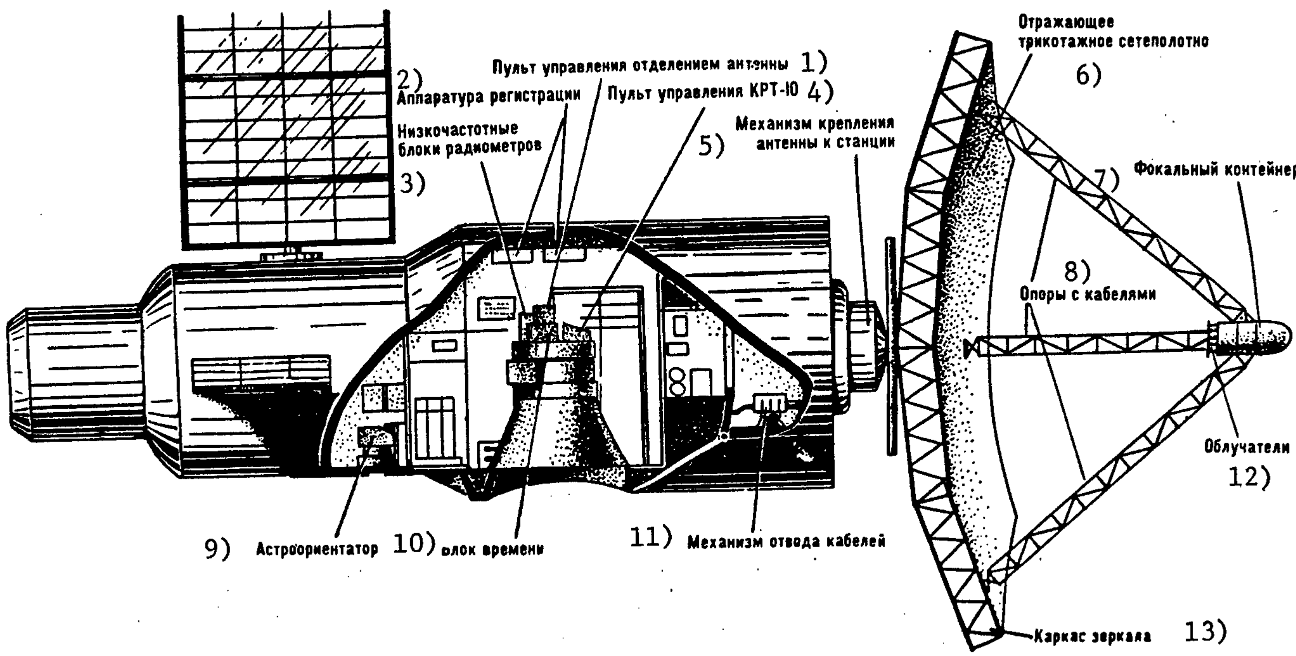


Diagram of placement of components of KRT space radiotelescope aboard the station "Salyut-6."

KEY:

1. Control panel for deflecting antenna
2. Recording apparatus
3. Low-frequency radiometer units
4. KRT-10 control panel
5. Mechanisms for attachment of antenna to station
6. Tricot reflecting curtain
7. Focus capsule
8. Supports with cables
9. Astroorientation unit
10. Time unit
11. Element for outlet of cables
12. Exciter
13. Dish framework

Such is a concise list of recent events in space research. We will discuss some of them in greater detail.

"Salyut-6" - "Soyuz"

I will begin with the results of the cycle of manned space flights in the "Salyut-6" - "Soyuz" orbital complex, beginning in 1977. Under the program of this cycle, 27 cosmonauts worked aboard the space station, of these six worked twice. Included were 9 cosmonaut-researchers from the socialist countries participating in the "Intercosmos" program: Czechoslovakia, Poland, East Germany, Bulgaria, Romania, Cuba, Mongolia, Vietnam. There were five main expeditions (among them, the most prolonged in history -- 185 days) and 11 expeditions constituting "visits." The total time of operation of the station in a manned regime under this program was 676 days.

The flights under the "Intercosmos" program for the most part pursued the following goals: study of the earth and its atmosphere from space, study of other space objects, and also the behavior of the human body during space flight and after it, improvement of space apparatus -- orbital stations and ships.

The presence of man aboard the "Salyut-6" station, especially for a long time and repeatedly (as in the case of V. V. Ryumin) yielded much information for increasing the effectiveness of man's work during the time of space flights.

The question sometimes arises: "Is it really necessary to send man into distant space?" In actuality, it is feasible to entrust many investigations in space and from space to automatic instruments and vehicles. In many cases this is both less expensive and does not present dangers for man. But man, at least in the first stages of perfecting methods, can carry out tasks much more rapidly and more completely. Accordingly, scientists continue to feel that manned flights and flights of automatic vehicles could not better supplement one another.

I will begin my exposition of the work carried out on the "Salyut-6" with radio-engineering experiments.

The BST-1M telescope serves for the reception of submillimeter radio waves (radio waves with a length of less than 1 mm). They do not propagate from space to the earth through the atmosphere and therefore it is very desirable to know what is being done in this wavelength range. The experimental technique was perfected at once. The fact is that the receivers for this wavelength range are cooled by liquid helium, which at all time is boiling, and it was important to overcome the difficulties associated with this process under weightlessness conditions. One of the interesting results obtained with the BST-1M was the discovery of anomalously strong radiations in areas of thunderstorm formation. The KRT-10 radiotelescope was also tested on the "Salyut-6"; it operates at wavelengths of tens of centimeters (ZEMLYA I VSELENNAYA, No 4, pp 2-9, 1980 -- Editor). These wavelengths are easily propagated through the atmosphere and therefore from space it is possible to observe radio waves emanating from the earth, regardless of time of day, clouds and thunderclouds.

On the basis of the radiation of radio waves we have now learned to determine waves on the oceans and the water temperature in them with an accuracy of approximately 2°, soil moisture content with an accuracy to 10%, water content

in the atmosphere in the form of vapor and droplets in clouds and thunderclouds. These data will have great importance in preparing weather forecasts and understanding processes determining weather.

Space radiotelescopes also make it possible to observe very distant objects in space. The fact is that the larger the telescope dish, the better will be its angular resolution. On the earth, by placement of radiotelescopes on different continents, it was possible to obtain a resolution of a hundred millionth of a radian, that is, 1000 times better than for optical telescopes. In other words, we can examine an object with a size of several meters at a distance corresponding to the distance from the earth to the moon. Astronomers want to see the most distant objects, and for this it is necessary that one of the radiotelescopes be sent beyond the limits of the earth on a spaceship.

On the "Salyut-6" cosmonauts have been greatly concerned with visual observations of the land and water surface and have photographed them by means of special cameras giving a color image. The cosmonaut himself determined what to photograph and how to do it best. Tens of thousands of photographs were taken. The cosmonauts discovered earlier unknown faults in the earth's crust, promising regions in which to explore for petroleum and other minerals. The collected materials are already being used in compiling a new tectonic map of the USSR and in seeking for mineral resources. Observation of volcanoes in the Kurile Islands from space indicated that some volcanoes, earlier considered extinct, may become active.

Space technology occupied a considerable part of the program. Some experiments were for explaining the essence of the physical phenomena in a state of weightlessness; others were for assisting in developing the technology for obtaining in space valuable materials which are needed in a relatively small quantity, especially in the fabrication of miniaturized elements for radioelectronic instruments (ZEMLYA I VSELENNAYA, No 2, pp 28-32, 1982 -- Editor).

Finally, in the "Salyut-6" program there was testing and checking of the station itself, the possibility of its repair during the course of flight, and also transport ships. The results will be taken into account in subsequent construction work.

L. I. Brezhnev, General Secretary, Central Committee CPSU and Chairman, Presidium of the USSR Supreme Soviet, in discussing the prolonged manned flight in the "Salyut-6" - "Soyuz" orbital complex, noted that this is a scientific, technical and organizational feat, but most of all a purely human feat. Man has taken a new, significant step in learning the secrets of the universe and bending them to his will and reason. This step will forever stand out in history.

Solving Secrets of the Universe

A major success of our science, space and instrument-making technology was the flight of the "Venera-13" and "Venera-14" space stations to the planet Venus and the descent of automatic modules onto its surface. These stations continued

the program for investigating the planet closest to us. They were supplied with modern informative scientific instrumentation and yielded much new material. With respect to breadth, completeness, scientific and technical level the experiments on the "Venera-13" and "Venera-14" far surpass all preceding experiments made on Venus and other planets by both our own scientists and by American scientists.

Why are we interested in Venus? Because this is the planet closest to us, in size approximately the same as the earth. The conditions for its illumination by the sun are also approximately the same. Scientists are greatly interested not only in the earth's past (it should assist in a better understanding of our present), but also its future. For the time being we have only been able to study terrestrial processes. Now it has become possible to learn how matters stand on another planet exposed to similar conditions.

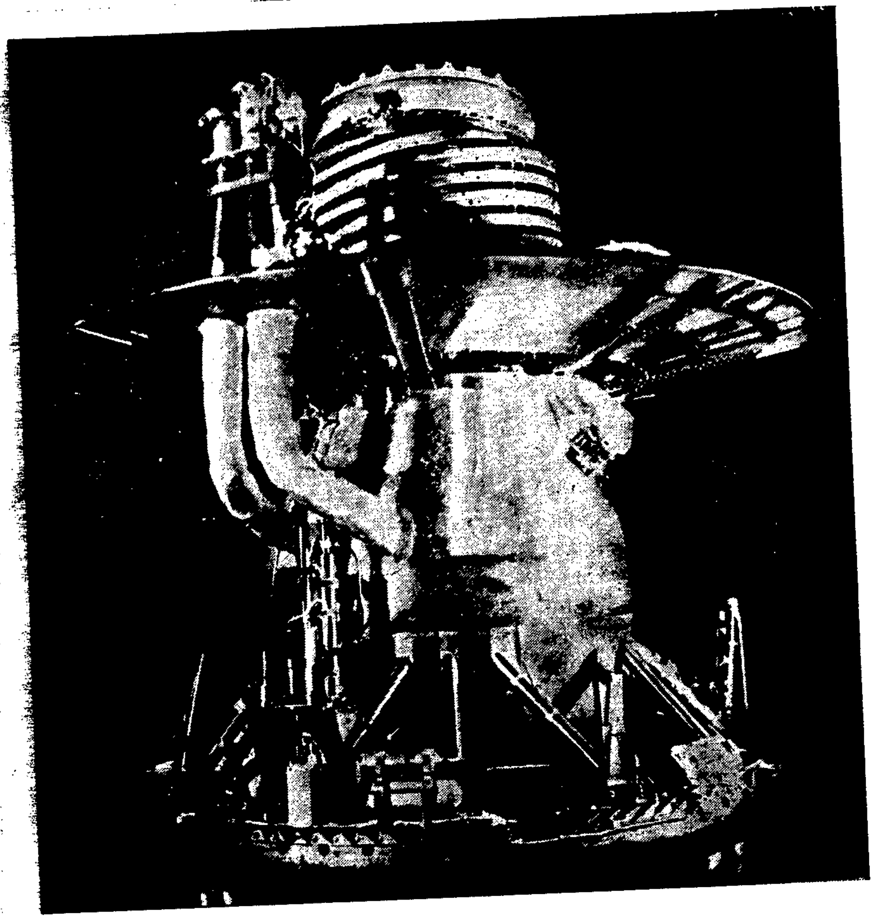
Space investigations and radioastronomy have brought much which was unexpected. Venus was found to have an exceedingly dense atmosphere; the pressure at the surface is about 100 atm and the temperature is almost 500°C. It was found that the planet rotates very slowly (one rotation in 243 earth days). At the time of its closest approach to the earth Venus always turns one and the same side toward us. The cloud layer which always covers its surface rotates much more rapidly than the planet itself (one rotation in four earth days). In general, the conditions on Venus were mysterious and different from those on the earth. What we see is an earlier stage in the development of a planet and our earth has already passed through this stage or perhaps our earth is yet to experience it. In the process of industrialization the quantity of released heat is constantly increasing. Will this bring us closer to the situation which prevailed on Venus? Or is the development of Venus proceeding in a completely different direction from that which our planet is taking? Science, naturally, must answer these questions.

What did we find out from our last flights to Venus?

First, the atmosphere was further investigated. The measurements of the UV component of the flux of solar radiation, made for the first time, indicated that a considerable part of it is absorbed at altitudes greater than 60 km, heating the atmosphere. It is not impossible that this is tied in to the unusually rapid rotation of the cloud cover, lying for the most part at these altitudes.

Also for the first time it was possible to measure the content of all the inert gases in the atmosphere and many of their isotopes. This is very important for unraveling the secrets of the origin of Venus and the planets in general.

Different methods have been used for determining the content of water vapor in the atmosphere. For reasons which cannot be understood there was very little. It could be demonstrated by direct methods that sulfur is the principal element in the cloud layer. It was seen with great surprise that on Venus the sky is of an orange color and therefore everything has an orange hue.



Descent module of "Venera-13" automatic interplanetary station*.

But information on the planet's surface was of the greatest interest. Black and white photographs were obtained (with a greater resolution than before) and for the first time color photographs were obtained for the neighborhood of the landing sites. In addition, a special drill took samples of rock which were transferred through a lock into the vacuumed analyzer space of an x-ray fluorescent spectrometer. The resulting spectra (about 60 were obtained) were transmitted by radio to the "Venera-13" and "Venera-14" stations and from there through powerful radio transmitters to the earth. (Images and other telemetric information were also transmitted to earth from instruments situated on the surface.)

An analysis of the spectra even now has "told" of the content of potassium, magnesium, silicon, aluminum, calcium, titanium, manganese and iron present in the ground. Investigations are being continued for detecting the elements present in lesser concentrations and heavier elements.

It should be noted that despite the very severe conditions prevailing on the Venusian surface better accuracies have been attained than on the American space vehicle making a landing on Mars. The chemical composition of the rocks

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* This photograph, like the others in the article, is from the TASS photographic archives.

indicates that in the region of landing of the descent module of the "Venera-13" station there is leucitic basalt which experiences chemical weathering. This agrees well with the appearance and texture of rocks observed on the panoramas.

A knowledge of the chemical composition of the rocks will make it possible to compute its primary mineral composition and the composition of the secondary minerals arising under the influence of the aggressive Venusian atmosphere, to determine the conditions for the formation of the melt, the depth of its generation and at the same time, the degree of melting of the Venusian mantle. In other words -- recreate the physicochemical conditions of its formation.

The composition of the rock in the region of landing of the "Venera-14" module was different. It corresponds to the composition of the oceanic tholeiitic basalts occurring widely on the earth. But these rocks cannot be considered a result of outpourings of lava. In all probability these are the products of accumulation of a mixture of ash and fine crystalline fragments of rocks and minerals ejected during explosive volcanic eruptions and the compaction following them. The absence of appreciable secondary changes of rocks indicates their young age and the very fact of explosive volcanic eruptions is indicative of the presence of appreciable quantities of water in the magma. This makes questionable the hypothesis that Venus was characterized by an initial impoverishment with respect to water.

Soviet and French gamma-ray detectors were carried aboard the "Venera-13" and "Venera-14" stations. These register suddenly developing flares, or as they are called, bursts of these rays (ZEMLYA I VSELENNAYA, No 1, pp 34-36, 1980 -- Editor). By determining the time difference in the times of the gamma bursts it is possible to compute the direction from which they have arrived. The precise reason for the occurrence of these bursts is unknown. Usually they last for several seconds and probably arise during major space catastrophes. During the time of flight of the "Venera-13" and "Venera-14" about 30 bursts were registered. Surface receivers cannot register them because gamma bursts do not pass through the atmosphere. A study of gamma bursts should explain the nature of still another form of grandiose processes in space.

Theory of Planetary Motion

As an event facilitating our space investigations we should note the completion in 1981 of the formulation of a refined theory of the motion of the inner planets (Mercury, Venus, Earth, Mars). This theory now makes it possible to precompute the distance between the planets with an accuracy to about 1 km and their velocity with an accuracy to about 1 cm/sec, which is tens of thousands of times more precise than 20 years ago prior to the appearance of radar astronomy and flights of spaceships to the planets. The theory is not based on the Newtonian equations, but on the general theory of relativity and uses optical and radar measurements of positions of the planets. Radar measurements now have a surprising accuracy -- with our space radar located in the Crimea we measure the distance to Venus with an error of about 300 m at the time when the distance to Venus is 100 million kilometers.

Radiotelescope

The introduction of a radiotelescope with a dish diameter of 70 m into operation is unquestionably of great importance for our space research. It operates at wavelengths from 1 cm. At the present time this is the best radiotelescope of this class in the world. In order to have some idea concerning the uniqueness of this structure it must be remembered that the surface of this enormous dish is made with an accuracy to about 1 mm and retains such an accuracy with all rotations and inclinations. Indeed, the size of the telescope is that of a 25-story building. The telescope can operate for the transmission of radio waves (concentrating the waves into a very narrow beam) and for their reception. It is used for communication with space vehicles, especially for the transmission of commands to the stations "Venera-13" and "Venera-14" and for the reception of data from them; for radar observations of the planets and also radioastronomical observations.

During the past year our rockets have put two international satellites into space -- the "Intercosmos-Bolgariya 1300" and the "Oreol-3." The purpose of their launching is the continuation of multisided investigations of the upper layers of the earth's atmosphere and ionosphere with more perfect instrumentation. The processes in these layers exert an influence on the propagation of radio waves, magnetic storms, auroras and probably are highly dependent on nonstationary phenomena on the sun. The study of such processes has both practical and great scientific importance since evidently it makes it possible to understand many mechanisms of solar-terrestrial relationships. We will trace these relationships in different phenomena, but their mechanism by no means is always comprehensible.

During the past years systems using space for the purposes of the national economy have continued to be developed and improved: regular observations of the earth from automatic satellites in the interests of meteorology, agriculture and forestry, geology, navigation, communication and television broadcasting. The latter, as being the subject closest to me, will be discussed in somewhat greater detail. As a result of the use of communications satellites, five-zone TV broadcasting of Central Television program I and three-zone TV broadcasting of program II have already been introduced in the USSR (since October 1980). Central Television programs are now transmitted from Moscow at a time convenient for the residents of a particular zone. Television broadcasting (with a good quality) now is available to 87% of the population of the Soviet Union. The use of artificial earth satellites with more powerful radio transmitters has made it possible to simplify and lower the cost of receiving apparatuses and make them accessible for use in small populated places and on sea ships operating in the northeastern sector of the Arctic. The "Ekran" television broadcasting network using such satellites is a truly massive system and it now has about 2000 receiving apparatuses.

The possibilities of total coverage of the country by TV broadcasting appeared with the creation of a satellite television system operating in the range 4 GHz, given the name "Moskva." It will be able to service any regions of the country, especially the European USSR, Urals, Central Asia and the Far East, since it does not create noise for ground services. The use of a transmitter of increased power and an antenna with a narrow directivity diagram in this

system (on the geostationary satellite "Gorizont") made it possible to achieve a considerable simplification and lessening of the cost of a receiving station in comparison with the "Orbita" station and change over from antennas with a dish having a diameter of 12 m to simple and inexpensive antennas with a dish having a diameter of 2.5 m. Even now a network of 100 such stations is in successful operation and the possibility has been checked of the reception of images of newspaper columns by these stations. Using such a system, newspapers can be transmitted directly to the print shop, which eliminates the necessity of constructing expensive land connection lines and makes possible a substantial increase in the number of cities in which the central newspapers appear simultaneously with Moscow.

The creation of "Gorizont" satellites was favored by the development of the international satellite communication organization "Intersputnik." It includes: Afghanistan, Bulgaria, Hungary, Vietnam, East Germany, Cuba, Mongolia, Poland, Romania, Czechoslovakia, USSR, Yemen, Laos, Syria.

About 40% of the entire television exchange between these countries occurs through the "Intersputnik" network of land stations and since 1 February 1982 a daily television exchange of news has been organized.

Space technology is assisting the national economy to an ever-greater degree.

The 26th CPSU Congress placed new tasks before us, including the mastery of space. Without question, we are encountering the 60th anniversary of the Soviet Union with new achievements in the study and use of space.

5303
CSO: 1866/43

CONTROL OF SPACE EXPERIMENTS

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 7, Jul 82 p 31

[Text] The extensive program of research and experiments, accomplished on the orbital space stations of the "Salyut" type, has been thoroughly discussed in articles published in the periodic press in recent years. The "Salyut-6" flight established records both for the quantity of research, and duration of flight. The experience gained leads to the conclusion that the effectiveness of the findings of scientific research in space largely depends on their support and operational control.

The preliminary program of experiments, as is known, is worked out in advance, but its detailed, timely implementation is difficult because of objective causes. Therefore, the necessity arose for the operational control of the course of an experiment on board a space station or craft. What is the difficulty in this? First of all they are dependent on the short time of the effects of the prediction (ballistic, meteorological, activity of the crew and the functioning of the scientific apparatus). The fact that the scientific devices being used often have less reliability should also be considered. A method based on an initial observation of a phenomenon is not always perfect. Of course, because of the receipt of scientific data and its operational analysis, it is amplified and refined, which inevitably leads to the review of the preliminarily-developed program.

The control of experiments, in essence, starts with operational planning. In other words, it is necessary to develop the task in such a way that specific conditions arising in the flight do not upset the accomplishment of the long-term scientific research program. The number of experiments, the periodicity and time of their performance, the degree of preparation for utilizing scientific apparatus and other equipment stowed on the spacecraft, the degree of compatibility of various experiments--all of this must be taken into consideration during planning. The quantity is established by the nominal research program. In the course of the flight it may be changed. Of course, the extent of its increase is limited by technical feasibility, such as the resources used by the space station's systems. The periodicity and time for conducting the experiments is established, basically, according to data of operational analysis, mathematical modeling, and the results of ballistic calculations.

Preparation of scientific apparatus and systems, preserved in storage, demands considerable time. This often adversely impacts on the effectiveness of the planning. It is necessary to reconcile oneself to this, since the maintenance of a set of instruments in ready condition might decrease their service life or have other undesirable effects.

With the aim of increasing the effectiveness of the research, it is necessary to combine or accomplish simultaneously several experiments, to the extent that the technical characteristics of the space station and the capacity of the crew permit.

For the accomplishment of scientific research, an entire complex of means is required: command-measuring points, astronomical observatories, airborne geophysical laboratories. In the ground-spacecraft control complex a huge flow of scientific information is circulated and its quantity grows as the program is implemented. The overall effectiveness of the program depends largely on the timely receipt of information by the consumers.

Resolving problems of control implies using methods of theory of research operations and the theory of large systems. Their realization is brought about by the ground-spacecraft complex for controlling experiments. In addition to the ground analysis and control, the space apparatus itself plays a role. Resolving parts of these problems on board, by processing, analysis and control of the experiments, allows a considerable shortening of the information flow transmitted to earth. No small role is taken by the cosmonauts. The quantity and maintenance of the planned experiments depends in large part on their initiative, efficiency and interest.

12198
CSO: 1866/130

UDC 629.015+531.38

EVOLUTION OF ORBITS IN PLANE, LIMITED, ELLIPTICAL, TWICE-AVERAGED THREE-BODY PROBLEM

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 26 May 81) pp 332-341

VASHKOV'YAK, M. A.

[Abstract] The author investigates the plane, limited, elliptical, twice-averaged three-body problem for arbitrary values of the ellipse's major semiaxis and eccentricity, using a numerical analytical model. He explains the method used to compute the secular part of the perturbing function, analyzes the conditions for intersection of the disturbing body with the orbit, conducts a qualitative investigation of the structures of families of integral curves in the plane of the eccenctricity and its pericenter, and derives a formula for computing the extreme characteristics of evolving orbits. He concludes that although the relationships he has derived make it possible to make an approximate determination of the basic extreme characteristics of families of integral curves and the boundaries of the areas corresponding to nonintersecting orbits of a point of zero mass and a perturbing body, the temporal characteristics of orbital evolution for arbitrary major semiaxis and eccentricity values require further study. Figures 8; references 10: 9 Russian, 1 Western.
[113-11746]

UDC 537.525.1

INVESTIGATION OF PLASMA MANTLE OF EARTH'S MAGNETOSPHERE: 2. ION COMPOSITION

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 12 Mar 81) pp 387-398

ZAKHAROV, A. V., DUBININ, E. M., PISARENKO, N. F., LUNDIN, R. and HULTQUIST, B.

[Abstract] Using information available in the literature and data gathered by the "Prognoz-7" artificial Earth satellite in the first half of 1979, the

authors discuss the effect of the new information on previously held ideas about the ion composition of the Earth's magnetosphere, the main point being that the ionosphere contributes a much greater share of the ring flow's ions that was previously supposed. They also discuss three instances of the satellite's crossing of the high-latitude boundary layer during weak, relatively severe and extremely severe magnetic storms. Finally, they present some quantitative and qualitative conclusions. Figures 6; references 12: 1 Russian, 11 Western.
[113-11746]

UDC 550.388

RADIO-FREQUENCY EMISSION OF INJECTED ELECTRON BEAMS FROM VIEWPOINT OF IONOSPHERIC PLASMA DIAGNOSTICS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 4 May 81) pp 407-411

VLASOV, V. G.

[Abstract] The author discusses the possibility of radio-frequency emissions from injected monoenergetic electron beams in the Earth's ionosphere that are collimated along the magnetic field and the use of these emissions for diagnostic purposes. He finds that information about ionospheric electron density can be obtained only if there is no plasma-beam discharge; that is, if the injection takes place in the diurnal F-zone of the ionosphere and the injection time is $\ll 10^{-3}$ s. As far as a powerful auroral beam in a severe turbulence mode in the F-zone is concerned, the process of stabilizing it with modulation instability and its possible "collapse" in the E-zone should manifest itself as intensive radio-frequency emissions on the doubled plasma frequency, registration of which should be regarded as evidence of beam instability, whereas the emissions' amplitude-frequency-time characteristics should make it possible, in principle, to recover the dynamics of the development of the beam instability. References 12: 10 Russian, 2 Western.
[113-11746]

UDC 551.521

DIRECTIVITY OF X-RAY RADIATION IN SOLAR FLARES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 23 Mar 81) pp 417-421

BELOVSKIY, M. N., OCHELKOV, Yu. P., PEREYASLOVA, N. K. and USTINOV, A. V.

[Abstract] After reviewing what has been learned and hypothesized about the directivity of X-ray radiation in solar flares, the authors use data gathered

by "Solrad" spacecraft from 1967 to 1974 to study flares in the 0.5-3 A (4.13-24.8 keV) and 1-8 A (1.55-12.4 keV) ranges by investigating the two-dimensional distribution functions of the number of flares with respect to solar longitude and intensity. Their conclusions are: 1) there appears to be no directivity of X-ray flares in the investigated bands; 2) the flares' distribution functions with respect to intensity in these bands are exponential, with a bend for low intensities; 3) the observed solar longitudinal dependence of the number of flares cannot be caused by directivity of their emissions, but is apparently related to statistical fluctuations in the number of flares. Figures 2; references 10: 3 Russian, 7 Western.
[113-11746]

UDC 523.165

RESULTS OF 'MARS-7' AUTOMATIC INTERPLANETARY STATION'S MEASUREMENT OF ELECTRON FLOWS WITH ENERGY LEVELS OF AT LEAST 40 KEV UNRELATED TO SOLAR FLARES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 16 Jun 81) pp 422-428

ALEKSEYEV, N. V., VAKULOV, P. V., VOLOGDIN, N. I. and LOGACHEV, Yu. I.

[Abstract] Using data gathered between August 1973 and March 1974 by gas-discharge counters aimed at angles of 45° and 135° to the "Mars-7" automatic interplanetary station's solar-oriented axis, the authors attempt to explain the fluctuations in electron flows with energy levels of at least 40 keV that are unrelated to solar flares. Qualitatively, the fluctuations in intensity--which increased by a factor of 10 during the measurement period and then started to fall-resemble the change in the intensity of flows of Jovian electrons. After comparing these data with those gathered by the IMP-8, "Mariner-10," "Pioneer-10" and "Pioneer-11" spacecraft, which were on different trajectories, the authors conclude that Jupiter emits electrons into interplanetary space, beginning at energy levels no lower than about 40 keV and going up to about 6 MeV. In addition: 1) the intensity of low-energy electrons increases by a factor of about 10 when the best and worst connections between the observation point and the source are compared; 2) the leading shock fronts of solar wind plasma flows moving at different speeds change the intensity of the Jovian electron flow substantially; 3) the different time lag in the appearance of maximums of electrons with energy levels of about 6 MeV and at least 40 keV indicates that these electrons probably have different transverse diffusion characteristics. Figures 2; references 15: 2 Russian, 13 Western.
[113-11746]

DIFFUSE COSMIC GAMMA-RADIATION WITH ENERGY ABOVE 100 MEV IN MIDDLE AND HIGH GALACTIC LATITUDES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 4 Jan 82) pp 429-434

NAGORNYKH, Yu. I.

[Abstract] The author compares data on diffuse cosmic gamma-radiation obtained with the GG-2M spectrometer's Cherenkov and scientillation counters on board the "Cosmos-856" and "Cosmos-914" artificial Earth satellites with earlier data obtained with the second-generation gamma-ray telescopes on board the SAS-2 and COS-B satellites. After dividing the galactic sphere into three latitudinal zones (0-30°, 30-60° and 60-90°), he computes the energy spectra of the diffuse galactic gamma-radiation for each of them, on the basis of all available material, and concludes that the "rigid" galactic component makes a significant contribution to these flows for energy levels up to several gigaelectronvolts. Figures 1; references 9: 4 Russian, 5 Western.
[113-11746]

UDC 621.031

PERIODIC SOLUTIONS OF THIRD TYPE IN PROBLEM OF MOTION OF SATELLITE OF 'TRIAXIAL' ROTATING SOLID TYPE, ALLOWING FOR PERTURBATIONS CAUSED BY QUITE REMOTE SOLID BODY

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 14 Apr 81) pp 474-479

SARKISYAN, A. S.

[Abstract] The author applies Poincare's small-parameter method to the problem of finding periodic solutions of the third type for the periodic motion of a passively gravitating material point in the field of attraction of a "triaxial" rotating solid, with due consideration for the perturbing effect on the point of a quite remote third body. His system consists of the Moon as the "triaxial" rotating solid, an artificial lunar satellite as the material point, and the Earth as the third body. After setting up the satellite's equations of motion in terms of canonical (Delon) elements related to a selenocentric, rectangular system of coordinates with fixed axes, he turns his attention to orbits with little eccentricity and concludes that solutions of the third type can exist under certain conditions. Figures 3; references 2.
[113-11746]

UDC 550.388.2

INVESTIGATING SPORADIC SOLAR RADIO EMISSION AND PARAMETERS OF EARTH'S IONOSPHERE ON 'INTERCOSMOS-KOPERNIK 500' SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 4, Jul-Aug 82 (manuscript received 9 Mar 81) pp 542-551

AKSENOV, V. I., ARTEM'YEVA, G. M., KOMRAKOV, G. P. and SKREBKOVA, L. A.

[Abstract] A study was made of the behavior of relative fluctuations of electron concentration as a function of altitude, geomagnetic latitude, magnetic activity and local time. The collected data were used in computing the mean relative electron concentration fluctuations (MRECF) in the same latitude and altitude intervals as the probability of appearance of inhomogeneities and graphs of their dependence were constructed for quiet and disturbed geomagnetic conditions. The investigation was based on data collected by the "Intercosmos-Kopernik 500" satellite. It was found that in the middle and equatorial latitudes the probability P of appearance of electron concentration inhomogeneities with MRECF $\geq$ 0.2% at altitudes 200-1500 km varies in the range from 2 to 60-70%. The MRECF values fall in the range from 0.3 to 2.5%. The mean P values and the MRECF values at nighttime usually exceed the corresponding daytime values in the same latitude and altitude intervals. The maximum probability of the appearance of inhomogeneities in the summer hemisphere (northern hemisphere) is above the maximum of the F_2 layer; in the winter hemisphere (southern hemisphere) the altitudes of the maximum probability remain the same in daytime and descend to the level of the F_2 region maximum at nighttime. With $K_p \leq 3$ the maximum MRECF values in the northern hemisphere were registered at altitudes 200-400 and 800-1500 km; in the southern hemisphere--at 800-1500 km. At the equator the maximum MRECF values are at 200-400 km. At altitudes 400-1500 km the P values at nighttime increase with transition from the equatorial to the middle latitudes. During period of increased geomagnetic activity ($K_p > 3$) the changes in the probability of appearance of inhomogeneities in the middle and equatorial latitude zones in general are insignificant. With an increase in geomagnetic activity there is a change in the nature of the dependence of the MRECF value on latitude in the equatorial and low latitudes at all altitudes at nighttime and at altitudes 200-400 km during daytime. These are but a few of the conclusions drawn from measurements with the high-frequency impedance probe carried aboard the mentioned satellite and operating at the working frequencies 3.1 and 15 MHz, ensuring measurement of ionospheric electron concentration in the range from 10^3 to $1.8 \cdot 10^6$ cm^{-3} and its inhomogeneities measuring from 0.5 to 100 km. Figures 6; references 8: 1 Russian, 7 Western. [2-5303]

UDC 581.521

VARIATIONS IN INTENSITY AND ANISOTROPY OF FLUXES OF LEAKING PARTICLES WITH ENERGIES EXCEEDING 30 keV

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 4, Jul-Aug 82 (manuscript received 2 Jun 81) pp 552-559

ALTYNTSEVA, V. I., DRONOV, A. V., KOVTYUKH, A. S., PANASYUK, M. I., POLEKH, N. M., REYZMAN, S. Ya. and SOSNOVETS, E. N.

[Abstract] A study was made of the dynamics of fluxes of leaking electrons with energies 50-80 KeV and protons with energies 210-320 KeV during the magnetic storm of 29 July 1977 and during a magnetically disturbed period ($K_p \geq 4$) on 8 April 1977. Measurements of fluxes of leaking and quasitrapped particles were made using differential spectrometers with semiconductor detectors carried aboard the "Cosmos-900" artificial satellite. The magnetic storm of 29 July 1977 was preceded by a prolonged magnetically quiet period with a duration of about 4 days. The leakage regions were determined as the range of latitudes where the intensity of leaking particles exceeded the background level by a factor of ~3. Regions of isotropization of particle fluxes corresponded to the range of latitudes in which the intensity of leaking particles was equal to or exceeded the intensity of quasitrapped particles. The analysis revealed that the structure of regions of isotropization of electrons and protons is substantially different: for electrons the isotropic fluxes are localized in narrow zones within the leakage region, whereas for protons they occupy virtually the entire leakage region. This is evidence that the structure and dynamics of the proton fluxes during magnetic disturbances reflect for the most part a convection process, but for electrons--primarily sudden magnetic field changes. The relative positions of the plasmapause and the region of proton leakage also indicate an effect of magnetospheric convection on the spatial-temporal variations of proton leakage. The strongest leakage of protons was in the evening-nighttime sector, for electrons--in the morning-daytime sector, in which the region of electron leakage was stronger and more extended in latitude than in the evening-nighttime sector. This indicates the importance of the influence of convection on the pattern of leakage of both protons and electrons: protons drift westward and electrons drift eastward. The region of proton leakage consists of a narrow low-latitude zone with an anisotropic pitch-angle distribution and an extended zone of anisotropic fluxes. During a strong substorm there is a high-latitude anisotropic zone in addition to these zones. The fluxes of leaking electrons approached a critical level, followed by strong pitch-angle diffusion, with leakage becoming isotropic. In the auroral region there was a cigar-shaped pitch-angle distribution of electrons in both the evening-nighttime and morning-daytime sectors. Figures 2; references 23: 14 Russian, 9 Western.
[2-5303]

UDC 581.521

PROPAGATION OF LOW-ENERGY ELECTRONS AS FUNCTION OF FLARE POSITION RELATIVE TO CURRENT LAYER

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 4, Jul-Aug 82 (manuscript received 1 Jun 81) pp 560-565

ZEL'DOVICH, M. A., KOVRIZHNYKH, O. M. and LIVSHITS, M. A.

[Abstract] A study was made of the possibility of electrons from solar flares reaching the earth as a function of the location of flare site relative to the projection of the current layer onto the sun's surface. Streams of electrons with energies > 30 KeV observed during the periods 1972-1974 and 1976-1978 were considered. These events occurred in the phase of dropoff of the 20th cycle and onset of the increase of the 21st cycle. The results of comparison of the maximum streams of electrons E and radio emission R were compared for 52 events, all represented in Fig. 1 and Table 1. The figure reveals a tendency to an increase in the flux of electrons with energies > 30 KeV with an increase in the radio emission flux at $\lambda \approx 10$ cm. This indicates that the radio emission flux at 10 cm is a good characteristic of the efficiency of electron generation in a flare. (Flares in the eastern hemisphere and near the limbs were not taken into account.) The maximum electron fluxes for these 52 events were compared with the position of their sources relative to the neutral line separating macroscale fields on the sun. It is shown that favorable conditions exist for the propagation of particles along the neutral line. The particles arrive without losses from flares distant tens of degrees from a point connected to the earth by a line of force of the interplanetary magnetic field with a given veloctiy of the solar wind. It is concluded that the E(R) dependence is distorted due to particle propagation effects. Electron propagation near the sun is essentially dependent on the structure of the magnetic fields in which the source is situated. If the source is situated within an "impregnation" (a closed region of a definite polarity measuring not more than 20° within an extended field of a different polarity) the conditions for the escape of electrons are difficult or the stream is so narrow that the likelihood of its detection drops off rapidly. When an active center is situated on the neutral line the flare particles move along it and can quite readily escape into interplanetary space connected to the observer by a line of force. Figures 2; tables 1; references 14: 5 Russian, 9 Western.
[2-5303]

UDC 523.72

MHD STRUCTURE OF INTERPLANETARY STREAM ACCORDING TO PLASMA AND MAGNETIC FIELD MEASUREMENTS ON 'PROGNOZ-7' ARTIFICIAL EARTH SATELLITE (VI STIP INTERVAL, 25 APRIL 1979)

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 4, Jul-Aug 82 (manuscript received 16 Sep 81) pp 566-571

ZASTENKER, G. N., OMEL'CHENKO, A. N., YEROSHENKO, Ye. G., IVANOV, K. G. and STYAZHKIN, V. A.

[Abstract] The article gives the results of an investigation of the MHD structure of the interplanetary stream of 25 April 1979 on the basis of plasma and magnetic field measurements made by the "Prognoz-7." These measurements were coordinated with measurements at other points in the interplanetary medium within the framework of the international project for investigation of propagating interplanetary phenomena (STIP). Simultaneously the "Gelios-A,B" circumsolar satellites were making measurements under the program of the VI STIP interval. During the period 18-25 April there were no powerful flares with an importance > 2f. There were several flares of importance 1 and coronal holes. Measurements of plasma parameters were made with an SKS spectrometer which included an electrostatic analyzer oriented on the sun and measuring the energy spectra of ions and three integral Faraday cylinders measuring the total stream of ions and the angles of its arrival. Magnetic field measurements were made with an SG-70 three-component ferrosonde magnetometer. The collected data are summarized in Fig. 2. In the study, emphasis was on the region of interaction between the rapid stream (hypothetically from a low-latitude coronal hole) and the slow solar wind. It was found that a specific strong discontinuity (boundary of the stream) divides the interaction region into a head shock wave with a dense hot turbulent magnetoplasma and a return shock wave with a strong regular magnetic field and cold plasma. The momentum acquired by the slow wind in the head wave is 4 times greater than the momentum lost by the fast stream in the return wave. Figures 3; tables 1; references 17: 7 Russian, 10 Western.
[2-5303]

UDC 523.165

HIGH-ENERGY ELECTRONS IN PLASMAPAUSE REGION

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 4, Jul-Aug 82 (manuscript received 20 Apr 81) pp 634-636

TSIRS, V. Ye.

[Abstract] The influence of the boundary of the plasmasphere on the distribution of high-energy particles has been poorly studied. This article

examines the fine-structure features of electron variations in a wide energy range in the plasmapause region. Data are given for about 100 satellite revolutions, providing information on fluxes of charged particles with energies $E_e > 20$, ~ 62, > 90, > 250, > 500 KeV, > 1.4 MeV and leaking electrons with $E_e \approx 62$ KeV obtained with different levels of geomagnetic activity. In pre-midday and pre-midnight sectors measurements were made at altitudes of about 1000 km, in the post-midday hours at altitudes of about 2000 km. The position of the plasmapause was determined using the K_p index. The nature of the observed changes is dependent on the energy of the particles. For a calm and moderately disturbed magnetosphere it is possible to discriminate fluxes in three energy intervals different in their variations. For the daytime magnetosphere, where the changes in fluxes of high-energy particles in the plasmapause are most clearly expressed, a comparison was made of the position of the plasmapause determined on the basis of the K_p index and on the basis of particle fluxes. The difference in the position of the plasmapause determined by these two methods usually was less than 0.2L. The very significant changes in particle fluxes in a wide range of energies in the plasmapause region probably can be used for its indication. The dropoff in the fluxes of trapped electrons with 20-250 KeV near the plasmapause is related to the interaction of these particles with VLF waves. This process leads to an increase in the diffusion of particles into the cone of losses, as is indicated as well by the appearance of leaking electrons in the plasmapause region. The double structure of the outer radiation belt registered by the "Molniya-1" under very quiet geomagnetic conditions is possibly also a result of loss of particles in the plasmapause. During strong disturbances there can be a predominance of acceleration and injection processes in the course of a substorm and dumping during ionocyclotron resonance. It is possible that this is why there is not such a clear picture of distribution of particles in the plasmapause as during quiet times. Figures 2; references 8: 3 Russian, 5 Western.
[2-5303]

UDC 523.165

CORRELATION BETWEEN LONG-PERIOD VARIATIONS OF ELECTRONS IN EARTH'S OUTER RADIATION BELT AND SOLAR WIND PARAMETER

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 4, Jul-Aug 82 (manuscript received 25 Jan 82) pp 639-641

BEZRODNYKH, I. P. and SHAFER, Yu. G.

[Abstract] Long-period variations of electron intensity with a duration greater than 24 hours in the earth's outer radiation belt have been observed repeatedly, such as by satellites of the "Raduga" series in 1977-1979. The article describes the results of "Raduga" measurements of this phenomenon at L ~ 6.7. The electron bursts registered on these flights were preceded by an increase in the velocity of the solar wind. A figure gives data on electron bursts during the 27-day synodic period of solar rotation; it shows

periods during which increases of electron intensity were observed. It is confirmed that there is a recurrence in increases in electron intensity with a period of about 27 days, indicating a correlation between the bursts and quasistationary disturbances in the solar wind. It was found that many quasistationary disturbances in the solar wind are accompanied by recurrent increases in electron intensity in the earth's outer radiation belts of greater intensity and duration than the increases associated with the effect exerted on the geomagnetosphere by flare streams. Quasistationary corpuscular streams of the solar wind which are accompanied by electron bursts in the outer radiation belt evidently emanate from active regions on the sun with a high level of flare activity, in contrast to the quasistationary corpuscular streams emanating from active regions with a low level of flare activity or from coronal holes. They carry along more highly ionized plasma containing high-energy particles embedded in its magnetic field. These particles, penetrating into the geomagnetosphere and being further accelerated there, give rise to the observed variations of electron density in the outer radiation belt. Figures 2; references 7: 4 Russian, 3 Western.
[2-5303]

UDC 551.510.535.4

[He^+] VERTICAL PROFILES IN OUTER IONOSPHERE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 4, Jul-Aug 82 (manuscript received 18 Nov 80) pp 641-643

YAICHNIKOV, A. P.

[Abstract] Mass spectrometer measurements of the concentrations of He^+ ions in the upper atmosphere indicate that He^+ ions are a minor constituent of the ionosphere. However, there are relatively few experimental data on vertical [He^+] profiles in the outer ionosphere; the profiles have been obtained in different latitude zones, at different times of day, with different levels of solar and geomagnetic activity. The concentrations of He^+ ions differ by more than an order of magnitude, are different in different experiments and the vertical [He^+] gradients frequently have opposite signs in the range 400-1200 km. Therefore the [He^+] variations in the outer ionosphere are great and it is difficult to determine the global pattern of [He^+] variations on the basis of available experimental data. The author gives data on the vertical distribution of He^+ ions in the outer ionosphere during the daytime hours in a year of minimum solar activity and proposes an explanation of the vertical profile--the "trough" at 600 km. [He^+] measurements were made in the altitude range 400-2000 km, longitudes 20-150°E, during the period February-May 1964. Measurements for only 17 revolutions are given. The position of the [He^+] maximum below the [H^+] = [O^+] transition level is evidence of a nonequilibrium distribution of He^+ ions in the outer ionosphere at the solar activity minimum. Therefore, in computing vertical [He^+] profiles the ion fluxes must be taken into account and in particular, allowance must be made for the interaction of He^+ and O^+ ion

fluxes. The "trough" in the vertical [He^+] profile is tied in with the change in the sign of the flux of O^+ ions near 600 km. Figures 1; references 16: 7 Russian, 9 Western.
[2-5303]

UDC 523.164.32

THEORY OF BURSTS OF TYPE IV SOLAR RADIO-FREQUENCY EMISSIONS

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 59, No 4, Jul-Aug 82 (manuscript received 8 Jun 81) pp 742-749

LEDENEV, V. G., Siberian Institute of Terrestrial Magnetism, the Ionosphere and Radio Wave Propagation, Siberian Department, USSR Academy of Sciences

[Abstract] The author investigates A. V. Stepanov's hypothesis that Type IV radio-frequency radiation bursts from the Sun are caused by high-frequency conical instability in the magnetic trap. From the viewpoint of steady-state conical instability conditions (because of the long duration of Type IV bursts) and assuming a weak diffusion mode, he discusses the instability of electromagnetic waves in a magnetic trap and, using available experimental data, finds that Stepanov's proposed mechanism can account for the generation of these bursts. Figures 2; references 17: 16 Russian, 1 Western.
[30-11746]

UDC 524.35

HIGH-ENERGY, DIFFUSE COSMIC GAMMA-RADIATION, BASED ON 'COSMOS-856,' 'COSMOS-914' MEASUREMENTS

Moscow PIS'MA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 8, No 9, Sep 82 (manuscript received 29 Jan 82) pp 542-545

KALINKIN, L. F. and NAGORNYKH, Yu. I., Institute of Space Research, USSR Academy of Sciences, Moscow

[Abstract] GG-2M scintillation-Cherenkov spectrometers carried by the "Cosmos-856" and "Cosmos-914" artificial Earth satellites were used to measure gamma-radiation flows in all galactic latitudes for periods of 256 and 290 hours, respectively. The authors divide the celestial sphere into three latitudinal areas (low = 0°-30°, middle = 30°-60°, high = 60°-90°) and find that the data on all these areas coincide satisfactorily for both flights so that a combined spectrum can be used. Based on their analysis of the satellite data, they conclude that the results obtained by other

researchers for galactic radiation in near-equatorial galactic latitudes are correct and that in the middle and high latitudes, galactic components possibly contribute to the diffuse flows of gamma-radiation over a broad range of energies from hundreds of megaelectronvolts to several gigaelectronvolts. Figures 1; references 9: 4 Russian, 5 Western. [32-11746]

GAZENKO INTERVIEWED ON DEVELOPMENT OF SPACE MEDICINE

Moscow MEDITSINSKAYA GAZETA in Russian 1 Oct 82 p 3

[Interview with O. G. Gazenko, director of the Biomedical Problems Institute, by correspondent N. Panfilova on the occasion of the 25th anniversary of the launching of Sputnik]

[Text] On 4 October 1957 the world heard the call signs from space of the Soviet Sputnik, announcing the beginning of the space era for mankind. Behind this event stood the labor of hundreds of thousands of scientists and specialists and decades of hypotheses, ideas and experiments.

A vast contribution to the development of astronautics was made by biologists and physicians, who faced the complex problem of answering the question as to the feasibility and safety of manned space flight. Large collectives headed by the most prominent Soviet scientists participated in this work.

Among those present at the origin of space biology and medicine and participating in the performance of the first biological experiments and in the preparation for the flight of Yuriy Alekseyevich Gagarin was the director of the Biomedical Problems Institute of the USSR Ministry of Health, laureate of the USSR State Prize O. G. Gazenko.

Our correspondent N. Panfilova asked Oleg Georgiyevich Gazenko to tell how space biology and medicine have developed during these past 25 years.

[Question] Could you make a small digression into the history of the origin of astronautics.

[Answer] I am not a historian, so I shall not give a profound historical analysis of the events. I would like only to recall those circumstances which promoted the development of space biology and medicine. And I would begin with the 1920s and 1930s, which, it would seem were very far from the first steps into space.

Nevertheless, this was the time when Soviet and foreign scientists posed a number of fundamentally important questions that later confronted the conquerors of outer space. At that time a series of works by N. M. Dobrotvorskiy was published in our country. And in 1930 there appeared his very interesting book "Work in Flight." Here there were first formulated the main conditions for human activity in flight; medical measures were defined that must be taken in order to provide the maximum safety of work in flight.

Both Dobrotvorskiy's works, the unique investigations to study the deleterious effect on the human body of the acceleration factor conducted by a group of scientists under the direction of Professor N. A. Rynin and also the theoretical basis for human life-support during flight provided by members of the brilliant physiological school of Academician L. A. Orbeli became a solid foundation for the development of space biology and medicine.

In the 1940s scientists had already begun to question the biological effect of ionizing and ultraviolet radiation, as well as vacuum and high altitudes on the human body. The first biological experiments in aerostats and high-altitude balloons were also conducted at that time. The most diverse biological objects were investigated. The small fruit fly Drosophila became a classical object, widely used in modern "space medicine and biology."

[Question] Step-by-step towards the 1950's biologists gathered sufficient data on which to base further investigations.

[Answer] Yes. By this time rocket aircraft had appeared for conducting these investigations. Special centrifuges, decompression and anechoic chambers and terrestrial sources of ionizing radiation were developed in order to study factors of the space environment under terrestrial conditions. Of course only after a thorough study of the biological and physiological effect of deleterious factors of the space environment was it possible to begin to develop the means for protection from them.

[Question] But how could the effect of weightlessness be studied? It is of course impossible to reproduce weightlessness on earth.

[Answer] Only with the appearance of new aircraft. Experiments were commenced on high-altitude rockets, reaching heights of 110-150 kilometers, where for nearly eight minutes a condition of weightlessness was created. Special telemetric equipment made it possible to record and study the responses of a living organism placed on board. The scientists obtained unique data.

The day of the launching of the second artificial earth satellite, with a living creature on board, on 3 November 1957 we consider as the actual date of birth of space biology as a new direction in science. Further study of the influence of factors in the space environment on the living organism was conducted both under conditions of satellite flight and on earth. Human life-support systems were developed simultaneously. At that time we could already realistically postulate the feasibility of a man

existing under spaceship conditions. And the first flight of the Soviet cosmonaut Yuriy Gagarin confirmed this. The year 1961 became the year of birth of another scientific direction, that of space medicine.

[Question] Since that time 111 cosmonauts have been in space, spending a total of 8.5 years in orbit. The maximum flight duration is presently 185 days. What was space medicine's contribution in this?

[Answer] Our knowledge and resources expanded greatly during these years; approaches to the solution of a whole range of problems were changed.

What kind of person can complete a space flight? At the first stages we answered this question in favor of physically very healthy, young persons. Of course, today the health factor has not been withdrawn. But a no less important criterion has become the level of professional preparation of the future cosmonaut and the maximum effectiveness of his activity in orbit. Now we can send into space people of older age, for long periods and also women.

In speaking of preparation, an important place is now held by the development in cosmonauts of adaptive plasticity to unusual flight conditions--the ability to sustain extreme situations painlessly.

The implementation of the medical monitoring of the state of cosmonaut health during flight has also changed markedly. Research methods have also been expanded. Such instruments as, for example, the echocardiograph, which were earlier customary only for terrestrial experiments, have appeared at the orbital station. Today we can boldy speak of successes in the development of the sanitary hygienic and medical bases of cosmonaut life-support.

[Question] Yes, the achievements in the field of space biology and medicine are very numerous. But still, as one involved in space biology and medicine for all these 25 years, which achievements do you consider as major?

[Answer] Those gained in the area of stabilizing the health of cosmonauts. Principles and methods have been developed that make it possible to control the state of cosmonaut health. But I would not like to create the impression that all problems in this area have been solved. It is necessary to reach a still deeper understanding of the individual physiological characteristics of each person.

Physicians have not yet found completely reliable means for controlling the motion sickness arising at the onset of a flight, and the means for preventing electrolyte loss in the cosmonaut's body are not adequately effective. We must thoroughly learn to control all changes in the state of health of the cosmonaut.

We have travelled from 108 minutes to 185 days of stay of man in orbit. And the entire logic of the development of aeronautics says that in the future its development will move towards an increased duration of manned space flights. Assuring the safety of these flights presents space biology and medicine ever new and more complex problems.

9942
CSO: 1866/24

BLOOD CIRCULATION IN WEIGHTLESSNESS

Moscow ZDOROV'YE in Russian No 4, Apr 82 pp 10-11

[Article by O.G. Gazenko, academician, and A.M. Genin, professor: title as above]

[Text] At the dawn of the development of cosmonautics, when there appeared a real engineering possibility of realizing manned flight in an artificial Earth satellite orbit, the question of the possibility of living and working in weightlessness became an urgent one. It was necessary to analyze what disruptions in the activities of the cardiovascular system might arise in connection with spaceflight.

The fact of the matter is that gravity deforms blood more than anything else, and it is only the walls of the vessels that contain it that prevent it from spreading out. When acted upon by gravity, blood exerts pressure on the vessel walls that is compensated for by tension in their muscle layer and the rigidity of the walls and the surrounding tissues. Therefore, under the conditions of human life on Earth, particularly given man's vertical posture, the blood vessels in the lower part of the body are stretched somewhat by the hydrostatic pressure of the blood.

In order that blood circulation be carried out under these conditions, the volume of blood circulating in the body must be somewhat greater than is necessary to fill undistended vessels with blood. On the basis of some calculations and model experiments, the additional volume of the vessels that is caused by the effect of hydrostatic pressure (we will call it, provisionally, the "hydrostatic depot") can reach 12-18 percent of the total volume of circulating blood. In addition to this, high hydrostatic pressure in the vessels in the lower extremities results in an increase in the quantity of intertissue fluid because of plasma filtration, which frequently causes unnoticeable edema in the soft tissues.

What goes on in weightlessness from the moment the rocket engines are turned off in airless space until the moment they are turned on again or braking in the upper layers of the atmosphere begins?

The blood--as is the case with all the other human tissues and organs--loses its weight, in connection with which the hydrostatic pressure on the walls of the blood vessels disappears. The distended vessels in the lower parts of the body contract, their volume decreases, the "hydrostatic depot" disappears, and the blood contained in it moves to the upper part of the body, overfilling the veins in the head and increasing slightly the pressure in those areas where it is usually lower.

The intertissue fluid, which because of the drop in pressure in the lower parts of the body begins to return to the blood circulation system, is added to the blood that has moved from the lower extremities of the body. There is also an increase in pressure in the venae cavae, which discharge directly into the right auricle and an increase in the rate of influx of blood into the heart; consequently, the amount of blood discharged by the heart also increases. It would seem that there is nothing threatening taking place in the human body; on the contrary, the conditions for blood circulation should be made easier. However, excessive blood accumulation in the veins in the head and the blood vessels in the thorax, the increase in venous pressure and--particularly--the increase in pressure in the small blood circulation loop can cause deterioration of the brain's hemocirculation, increase the load on the heart's right ventricle, and increase the risk of the development of pulmonary inadequacy.

Thus, an excessive amount of circulating blood can prove to be just as disadvantageous for the body as an inadequate amount. Therefore previously it was possible to assume that in the body there are mechanisms that reduce the volume of circulating blood in case there is too much of it.

Actually, in 1956 the physiologists Henry and Hauer discovered a reflex that was later named for them. They established that distension of the left auricle by an excessive amount of blood causes the production of antidiuretic hormone by the rear part of the pituitary gland to slow down, which results in an increased loss of liquid by the body and, consequently, a reduction in the amount of circulating blood.

This is an extremely important but, apparently, not unique mechanism for normalizing blood circulation in weightlessness. There are possible others, including a change in the elasticity of the blood vessel walls and compensatory expansion of the vascular bed in some parts of the body.

Thus, the analysis of the possible disruptions of hemodynamics in weightlessness did not cause any serious apprehensions. The experience gained in the first manned flights confirmed this. Monitoring of the basic indicators of hemodynamics in weightlessness did not reveal any unforeseen reactions. Numerous studies by Soviet and American physiologists confirmed the hypothesis that during the first few days a human being is in weightlessness, there is a redistribution of the blood in the vessels, a loss of liquid by the body, and a reduction in the amount of circulating blood. During this period cosmonauts frequently experienced a feeling of blood rushing to the head, the mucus linings of the nasopharynx became swollen, and some facial edema was observed. These changes gradually grew milder and, in some cases, disappeared. No signs of disorders in vascular activity or blood circulation were detected either when the cosmonauts were at rest or when they were performing functional tests under a load.

A more dramatic situation is that of the return of cosmonauts to Earth after an extended expedition into space.

Adaptation of the blood circulation system to weightlessness means, at the same time, disadaptation to the effects of gravity.

For example, the reduction in the amount of circulating blood that is suitable for weightlessness means that when a cosmonaut returns to Earth, there can arise a

disparity between the capacity of the vascular network (to which the "hydrostatic depot" is added) and the actual volume of the blood filling it.

This means that when a cosmonaut attempts to stand up after completion of a flight, a disruption in the blood circulation process is possible. The return of blood through the veins to the heart can turn out to be reduced significantly, which means a sharp reduction in cardiac discharge, which can cause such a large drop in pressure in the arterial system that the brain's blood supply can prove to be insufficient. Such states frequently result in a loss of consciousness (orthostatic collapse).

The experience gained during the first flights into space also confirmed this hypothesis. Even after brief flights, immediately after landing we observed quickening of a cosmonaut's pulse, accompanied by a deterioration of the ability to do physical work and maintain a vertical position. These phenomena were expressed more clearly in the cosmonauts who completed the first 80-day flight in the "Soyuz-9" spacecraft.

It was necessary to develop and utilize a complex of methods and means directed at preventing blood circulation disorders in cosmonauts upon their return to Earth. The complex included intensive physical training during the flight, implementation of a series of procedures carried out immediately before the descent and directed at increasing the amount of circulating blood artificially, and the use during the descent of special clothing that constricts the lower extremities and prevents the distension of their vascular bed. The effectiveness of these measures was tested during a series of extended (up to 6 months) flights that were made by Soviet cosmonauts in the "Salyut" orbital stations.

Nevertheless, can we assume the problem of normalizing the blood circulation of cosmonauts during a flight and after its completion to be completely solved?

The answer is: not yet. The existing methods for preventing postflight hemodynamic disorders are extremely awkward. They take a lot of time on the part of the cosmonauts, and their effectiveness cannot be considered absolute. In order to optimize the entire system for maintaining a cosmonaut's health, the scientists are continuing to carry out comprehensive studies of human blood circulation during spaceflight and in modeling experiments on the ground.

11746
CSO: 1866/127

UDC 612.014

EFFECT OF SPACEFLIGHT FACTORS ON QUIESCENT NUCLEI OF SEVERAL PLANT AND ANIMAL MODEL OBJECTS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 26 May 80) pp 489-492

DELONE, N. L., ANTIPOV, V. V. and DAVYDOV, B. I.

[Abstract] The authors summarize the results of the effect of spaceflight factors on different types of air-dried, higher plant seeds, animals and pollen that were taken into space by different spacecraft and then returned to Earth. They discuss the effect of spaceflight factors on the "revivability" of seeds that had lost their ability to germinate (the percentage of seeds that germinated always increased, in comparison with a control group, after a flight), the liver cells of six steppe tortoises that were irradiated in space in the "Cosmos-690" satellite (their cell nuclei tended to be more homogeneous in size than those of all the different control groups, including the one that had also been irradiated on Earth), and the generative nuclei of the binuclear pollen Tradescantia paludosa (structural differences in the chromosomes were noticeable, they grew faster than the control group, and the second postmeotic mitosis occurred earlier). Figures 2; references 10.
[113-11746]

UDC 620.187;581.84:582.739

ULTRASTRUCTURE OF MERISTEM AND ROOT CAPS OF PEA SHOOTS UNDER SPACEFLIGHT CONDITIONS

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA B: GEOLOGICHESKIYE, KHIMICHESKIYE I BIOLOGICHESKIYE NAUKI in Russian No 6, Jun 82 (manuscript received 26 Feb 82) pp 78-80

SYTNIK, K. M., academician, UkSSR Academy of Sciences, KORDYUM, Ye. L., BELYAVSKAYA, N. A. and TARASENKO, V. A., Institute of Botany, UkSSR Academy of Sciences

[Abstract] The "Oazis" unit on board the "Salyut-6" orbital station was used to grow peas for period of 7 and 18 days, after which the last 3 mm of the

plants' main roots were fixed, dried and sectioned for study under a JEM-100B electron microscope. The authors present a detailed description of their findings and reach the following general conclusions: 1) there is disruption of the carbohydrate and lipid exchange processes under spaceflight conditions; 2) there is an increase or decrease in the activity of a number of enzymes; 3) the cytodifferentiation programs that are determined genetically on Earth are carried out, but because of the lack of a primordially rigid determination, biochemical and physiological processes change substantially. Figures 1; references 6: 5 Russian, 1 Western. [126-11746]

UDC 620.187:581.84.582.683.2

ULTRASTRUCTURE OF ROOTCAP OF ARABIDOPSIS THALIANA (L.) HEYNH UNDER SPACEFLIGHT CONDITIONS

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA B: GEOLOGICHESKIYE, KHIMICHESKIYE I BIOLOGICHESKIYE NAUKI in Russian No 7, Jul 82 (manuscript received 26 Feb 82) pp 79-81

TARASENKO, V. A., KORDYUM, Ye. L. and SYTNIK, K. M., academician, Ukrainian Academy of Sciences, Institute of Botany, Ukrainian Academy of Sciences

[Abstract] The structural and functional organization of the rootcap of Arabidopsis Thaliana (L.) Heynh was studied both under laboratory conditions and in the absence of gravity. An electron microscope analysis was made of the rootcaps of this plant cultivated in the "Svetoblok 1" instrument aboard the "Salyut-6" orbital station using an agarized nutrient medium under an illumination of 2000-4000 lux. Sprouts in the phase of two cotyledenous leaves were studied at the end of 60 and 65 days, in the first case in the budding stage, in the second case in the flowering stage-onset of fruit bearing. Light exposure in the first case was 2000 lux, in the second case 4000 lux. Spaceship experiments were paralleled by ground studies. It was found that the rootcap columella cells in the experimental plants were more vacuolized than in the controls. In the distal secretory cells in the rootcap there is an almost total lysis of the cytoplasm, organelles are absent and the cell content is represented by membranous conglomerates. A whole series of other discrepancies between the experimental and control material was noted. These data confirm facts established earlier by the authors and indicate that changes in the topography of the amyloplasts and their ultrastructure in cells of the central statenchyma of the rootcap under weightlessness conditions is the rule for higher plants; similar changes, for example, have been observed in Lepidium sativum (L.) in clinostate experiments. There is a close similarity of the biological effects of clinostat exposure and weightlessness at the structural level, strongly suggesting a similar mechanism of intensified vacuolization of cells under weightlessness conditions. References 5: 1 Russian, 4 Western. [144-5303]

UDC 523.33:523.43+523.42

INTERPRETING BIOLOGICAL EXPERIMENTS ON 'VIKING' SPACE VEHICLE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 4, Jul-Aug 82 (manuscript received 20 Jan 82) pp 651-653

GARBUZ, A. V., MUKHIN, L. M., ORLOV, S. L. and SHAFIYEV, A. I.

[Abstract] Data from biological experiments carried out by the American Viking probe do not provide a clear answer as to whether life exists on Mars. Various interpretations of the data have been published, and the authors now add another. The surface of the planet is constantly subjected to bombardment by high-energy particles of both solar and galactic origin. The effect exerted on Martian ground by high-energy particles should result in definite chemical changes in its composition. In the ground particles there can be an accumulation of molecular or radical products of radiolysis, electron hole defects, etc. The conditions at the Martian surface, such as slow weathering processes, low temperatures, very thin atmosphere, can favor stabilization and accumulation of considerable numbers of these defects, and this could cause the effect observed in the Viking biological experiments. The authors believe that the high initial rate of release of both tagged CO_2 and oxygen, with its subsequent slowing, is indicative of a purely chemical nature of the transpiring processes. It is postulated that the initial intensive release of gases is attributable to the participation of only the surface layers of ground particles in the reactions; the release of gases is slowed when the limiting stage in the transpiring processes becomes the diffusion of the reacting compounds to active particles from deeper layers. The authors made an effort at simulating the effect of high-energy electrons and γ-quanta on Martian ground. Use was made of rock samples with a content of elements close to those on Mars. The experiment revealed that one of the sources of gas release in the Viking experiments may be radiation defects accumulating in Martian ground under the influence of cosmic rays. Figures 1; tables 2; references 9: 3 Russian, 6 Western.
[2-5303]

DEVELOPMENT OF TOOLS FOR WORK IN SPACE

Moscow PRAVDA in Russian 19 Sep 82 p 6

[Article by A. Pokrovskiy: "Modified for Outer Space"]

[Text] I assume that my readers recall how confidently the "Elbruses" spoke from orbit on future "construction work" in near-earth space. Anatoliy Berezovoy and Valentin Lebedev envisioned there industrial plants that would at least partly free our planet of some harmful products, launching platforms for penetration to the depths of the solar system, and platforms for specialized scientific research.

Such complicated structures can scarcely be launched in their entirety from the surface of the earth. Rather, they will have to be put together in orbit.

The Salyut missions, as noted by Aleksandr Serebrov, who worked together with the "Elbruses", can be compared with reliable modular homes in outer space. But, figuratively speaking, these are only the first tents on the expanse of the virgin soil of space. And the pioneers working in them are approaching the time of space cities and industries, the "ethereal settlements" about which K. E. Tsiolkovskiy dreamed.

Naturally, in order to erect a "house" or simply to drive "the first stake for a tent", including a space tent, we at least need a hammer. But right now this seems natural twenty years after man has made himself at home in near-earth space.

At first this was brushed aside: "We have the latest space probe equipment. Who needs hammers..."

However, the increasing duration of missions has forced us to re-examine this attitude toward the problem. And in 1969, Andriyan Nikolayev and Vitaliy Sevast'yanov took with them a set of tools with a total mass of 740 grams on the first prolonged mission of a manned spacecraft. They had a screwdriver, scissors, pliers, a knife...For the sake of comparison, A. berezovoy and V. Lebedev had at their disposal 15 kilograms of various tools. But quantity is not the only thing involved here.

When in 1971 G. Dobrovol'skiy, V. Volkov and V. Patsayev attempted to remove a panel covering certain devices, three trained grown men were unable to cope

with a job that on earth would have been no problem for a child playing with an erector set. It was necessary to simply tear the panel off, and the designers had to give grave consideration to the problem of the kind of tool that can be conveniently used under conditions of weightlessness. This job was placed before the Moscow Scientific Production Association on Mechanized Building Tools and Finishing Machines (VNIISMI).

And here is the result, lying on the table neatly as in the surgery before an operation. Standing out among the shapes to which the eye is unaccustomed is an ordinary hammer with a wooden handle.

"And how did this come to be here?"

"It's for comparison. Try it."

The hammer rang merrily on the anvil, rebounding after each stroke. The arm involuntarily took up this recoil.

"Now try our hammer."

I struck, and my hand jumped of itself, expecting a recoil. But the hammer stuck to the anvil right away, as if held by a magnet. I raised it once more; no, no magnetic attraction could be felt.

"This is a recoil-less hammer. A space version of the ordinary hand tool."

Weightlessness has its own laws. A man working with a screwdriver or drill is turned in the opposite direction of the tool, and a secure support is not always to be found. And in fact, this was what caused the difficulty of the "Yantar's" when they were trying to remove the panel. And you know from your own experience that when a screwdriver slips off the head of a tightened screw it tears out tiny metal chips. On earth, these fall to the floor. But in a spaceship they begin floating in the air, and who would guarantee that they wouldn't get into eyes or respiratory passages?

And that isn't all. Tools must be convenient and safe when working in a spacesuit as well. This brings its own problems. Let us say that a substantial effort must be made to compress the fingers. This means that as much must be done in one squeeze as possible. And at the same time, God grant, there must be no damage to the spacesuit by a cutting edge or by a hammer recoiling after a blow!

The elimination of "terrestrial" disadvantages of tools was the job faced by the group of designers of VNIISMI led by M. L. Gel'fand.

Looking at the results of their work, one involuntarily thinks how inexhaustibly inventive people can be when they are dedicated to a job. Here everything was put to use: engineering features already well known, special inventions, and simple adaptation of quite unexpected items to space needs.

For example, the recoil-less hammer is a device that is generally known. Its head is partly filled with shot, which is what quenches the recoil. Then patent

descriptions (and the designers studied mountains of such literature) abounded with their own finds. The optimum head shape was sought. Even a circular head was tried. The best dimensions and the best amount of shot were determined. Hammers of different masses were tested to find the one giving the most effective blow -- remember, a certain effort is required just to pick up a tool. And this is how a hammer was produced in outer-space modification with a convenient handle that can also act as a pinch bar, with a lock, with a heavy recoil-less head.

"And this cutter has a still more unusual origin" we are told by one of the testers of the space tools, O. S. Tsygankov. "It is used to cut lines, cables and other soft materials, but must not even accidentally damage the surface of the spacesuit. Look here," and Oleg Semenovich squeezes the blade in his bare hand. "Not a mark. And do you know what was the prototype for this? an ordinary paring knife."

Electric tools will also be put to use in space. We recall that even on the Salyut-6 mission Valeriy Ryumin was to be the first to work with a soldering gun. When the appointed time came, the query from earth was:

"How are you doing with the soldering?"

"I've done it?"

"Please clarify. You've started?"

"I've finished. It's a fine tool just asking for a hand."

The descendant of this fine soldering gun is also lying right here on the table in front of us. It looks like a ballpoint pen with an electric cord.

"And" I am told, "that's just how it works, like a ballpoint pen. As it is drawn over the metal, a special substance is ejected by capillary forces and the soldering is done."

Alongside the soldering gun is an electromechanical tool of the future: a technological multipurpose recoil-less drive with a system of attachments that can be used to remove screws, cut metal bars, trim metal edges, drill and do a number of other operations without any reactive effect on the worker. The developers of space tools are getting ready for the most diverse operations of installation in near-earth orbit.

And astronauts are learning how to use these tools. During their EVA, Anatoliy Berezovoy and Valeriy Lebedev did the "Istok" experiment. The essence of this work was removal of a set of bolts with a wrench unlike any seen on earth -- with a guide rod in the center and balls along the sides. The bolts were also unlike their earthly counterparts -- they have a socket in the head for the rod, and depressions on the sides for the balls. The bolt comes out much easier and no sharp chips can form.

"Don't you think it's a good name for the experiment?" we are asked in conclusion by O. S. Tsigankov. "It's an acronym for ISsledovaniye Tekhnologicheskikh

Operatsiy v Kosmose [investigation of technological operations in space; the Russian word 'istok' means 'source']. But you know it could be interpreted in the direct meaning of the word as the start of something important."

That it could. The prose of space missions convinces us that we are at the source of ever greater space accomplishments.

6610
CSO: 1866/19

EQUIPMENT FOR COSMONAUT EVA

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 82 pp 31-34

[Article by G.G. Bebenin, doctor of technical sciences, and Yu.N. Glazkov, Hero of the Soviet Union, USSR pilot-cosmonaut, candidate of technical sciences: "What Is an Extravehicular Movement Pack?"]

> [Text] Special equipment will enable a cosmonaut to move around and maneuver outside his ship, in open space where there are no reference points. Various engineering problems are encountered in the designing of this equipment.

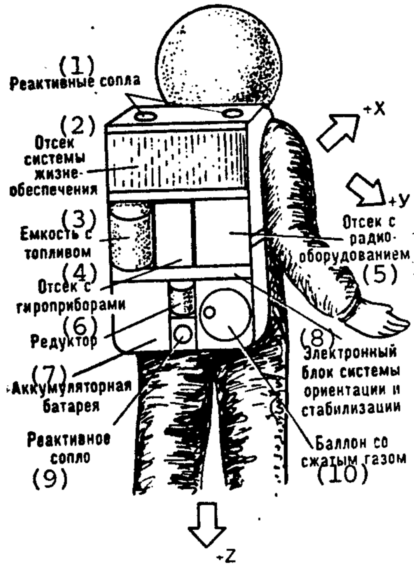
A complex of different types of technical facilities--railings, retaining clamps, special tools, space suits, orbital station airlocks--have been created so that man can work efficiently in open space (ZEMLYA I VSELENNAYA, No 4, 1977, pp 10-14). Having been trained to work outside his ship, a man can do a lot of things even with the help of these rather simple facilities. We are convinced of this, having seen how skillfully Yu.V. Romanenko, V.V. Kovalenok, V.A. Lyakhov, G.M. Grechko, A.S. Ivanchenkov and V.V. Ryumin worked in open space. However, immeasurably greater possibilities can be seen for extravehicular movement packs, which must include a number of systems: reaction motors, orientation and stabilization, life support and thermal regulation, among others.

Until now cosmonauts have not been faced with problems requiring the use of extravehicular movement packs. However, the time is not far off when large structures will begin to be put together in space. Then the cosmonaut will indeed need a "space taxi." The appearance of the extravehicular movement pack is already clear to the scientists. This is how they see it.

On the one hand, the pack has much in common with a spacecraft, but on the other they are also extremely different. Actually, the list of equipment in the pack includes most of the systems present in a spacecraft. However, it does have one characteristic special feature: the pack is much smaller than a spacecraft, which means that the systems is contains must be both smaller and lighter. Let us discuss the main ones.

LIFE SUPPORT SYSTEM

The conditions for normal human activity in open space are created by the life support system (together with a space suit).



Extravehicular movement pack for a cosmonaut.

Key:

1. Propelling nozzles
2. Life support system compartment
3. Fuel tank
4. Compartment with gyroinstruments
5. Radio equipment compartment
6. Regulator
7. Storage battery
8. Electronics unit for orientation and stabilization system
9. Propelling nozzle
10. Tank with compressed gas

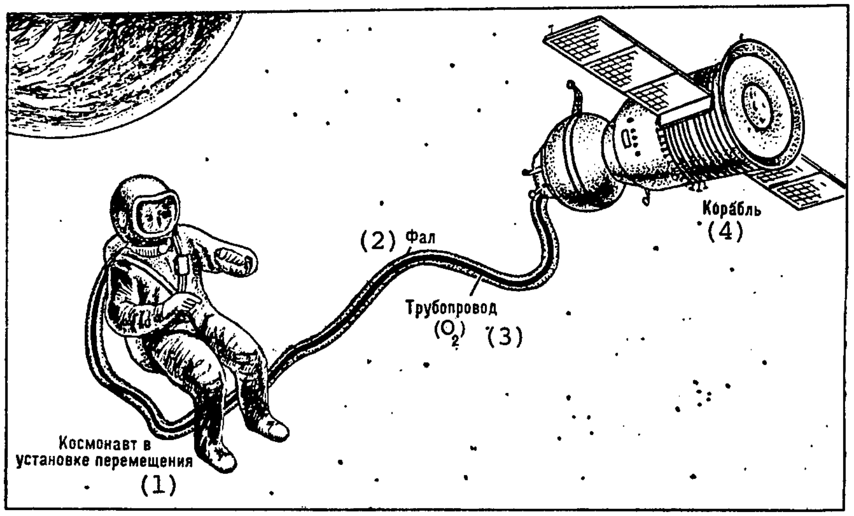
Foreseeing future human activity in open space, K.E. Tsiolkovskiy wrote: "One cannot be naked and work outside the artificial environment; that is, outside the living quarters. In the ether, in emptiness, workers and strollers alike must put on special protective clothing that is not unlike diving suits (the space suit). As do the closed living quarters, this equipment will supply oxygen and absorb the products of human excretions. This is a simplified description of close living quarters that cover only the body. The only difference is that the oxygen is not produced by plants, but is stored beforehand and dispensed little by little. Special types of glass will be used to protect against the deleterious effect of solar rays. This clothing, which will be impenetrable by gasses, will have sufficient flexibility and strength to maintain the gas pressure while not hindering the movement of the limbs. Organic excretions will be absorbed and the humidity inside the clothing regulated. The color of the clothing should correspond to the desired temperature."

The prophecy of this great scientist is coming true: a life support system and a space suit will enable man to live and work in open space. The system supplies the cosmonaut with oxygen, maintains the proper gas mixture, and absorbs carbon dioxide and harmful impurities. Oxygen can be supplied from the reserves stored on board the spacecraft or station. This is achieved by the use of a unique pipeline that connects the ship and the cosmonaut. The pipeline is placed in a halyard, which can also contain electrical leads for a telemetric measurement or radio communication system. In addition to this, the halyard connects the cosmonaut to the ship reliably and guarantees him a high degree of safety in open space.

Incidentally, it is also possible to supply the cosmonaut with oxygen by another method: an independent system has been created. In tanks similar to those used by scuba divers, reserves of oxygen are stored in compressed form and fed into the space suit through a reduction valve that reduces the oxygen's pressure. Carbon dioxide and harmful impurities are eliminated with the help of absorbers that contain lithium oxide and activated charcoal.

THERMAL REGULATION SYSTEM

This system maintains the cosmonaut's body temperature within given limits and a normal moisture content in the gaseous medium. How does this system work? Gas or



Cosmonaut, in extravehicular movement pack, attached to ship by halyard. He receives oxygen through tubing inside the halyard.
Key:
1. Cosmonaut in extravehicular movement pack
2. Halyard
3. O_2 line
4. Ship

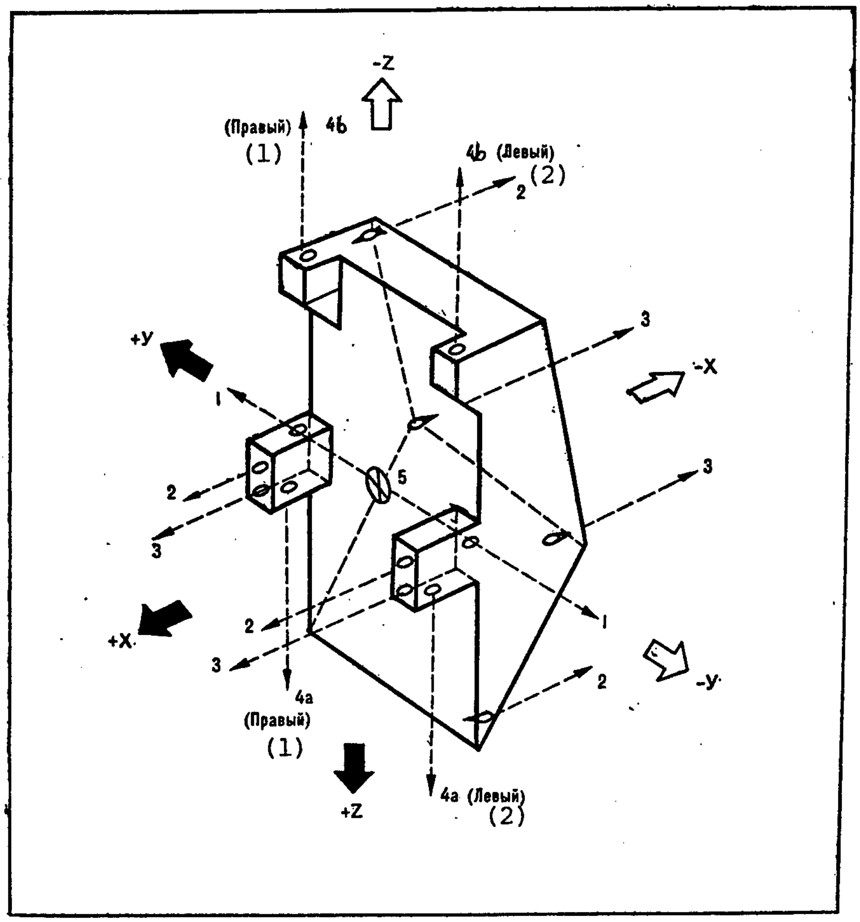
water, for example, is used as the heat carrier, which, when heated by part of the cosmonaut's body heat, keeps him from overheating. Forced ventilation, which causes the gas to circulate through the space suit, is used for this purpose. A water system works differently: the cosmonaut wears clothing that contains a network of tubes through which water circulates. In carrying off part of the heat generated by the cosmonaut, the heat carrier is warmed and then cooled in heat exchangers that radiate into space, after which it is again used to cool the cosmonaut's body. This is how temperature regulation takes place. The required temperature can be maintained either manually or automatically.

REACTION MOTOR SYSTEM

The control of a cosmonaut's motion in space, where there are no reference points, must not be reduced to mere progressive movements "up-down," "right-left," or "forward-backward." It must also take into consideration the free rotation around the center of mass.

The pack is equipped with reactive microengines. For progressive movement (three degrees of freedom) at least six engines are needed. And in order that a cosmonaut might revolve around a center of mass (this cannot be done without six degrees of freedom), a reactive motion system consisting of 12-16 motors is required. Such a system also provides a high degree of reliability, because of redundancy. The motors operate on compressed gas that is emitted from a nozzle. The compressed gas supply can be replenished either by replacing the tanks or by refilling them from supplies on board the ship or station. The essential shortcoming of this system is the low rate of gas discharge.

A considerably greater velocity (which means more efficient control) can be obtained with motors using hydrogen peroxide or two-component fuels. However, the



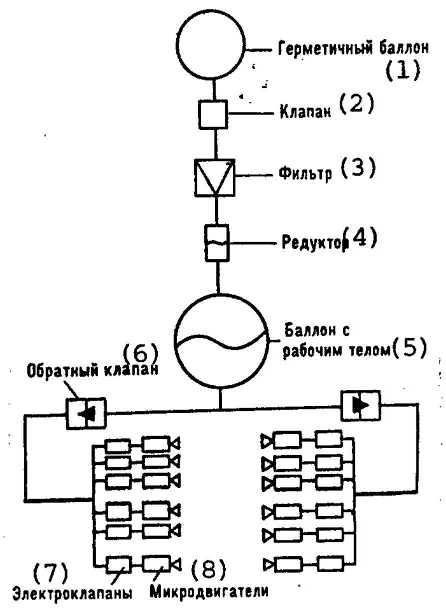
Layout of extravehicular movement pack's reactive motors: 1. nozzles for left-right movement; 2. nozzles for forward-backward movement and rotation; 3. nozzles for rotation; 4. nozzles for up-down movement and rotation; 5. center of mass.
Key: 1. Right 2. Left

temperature of the gasses coming out of the nozzle is too high (it reaches 800°C during the decomposition of hydrogen peroxide), which makes additional demands on the space suit's thermal shielding.

How do the reactive motors work? A supply of gas is stored under high pressure in a sealed tank. Through an electrically controlled valve and a filter, the gas is fed into a reduction valve. Here its pressure is reduced, after which it is sent into a tank containing the working body (hydrogen peroxide, for example). The peroxide expelled from the tank by the gas is fed into the micromotors through one-way valves and decomposes into atomic oxygen and water vapor. The decomposition products create the reactive force as they are discharged through a nozzle.

The control signal sent to the electric valve directs the peroxide into the needed motors. When there is such a signal the valve opens and peroxide enters the micromotor's combustion chamber. If there is no signal, the valve remains closed.

Different variations of the arrangement of the micromotors are possible. For example, for movement upward (in the direction of the -Z axis) it is necessary to turn on



Schematic representation of system of propelling motors.

Key:
1. Sealed tank
2. Valve
3. Filter
4. Reduction valve
5. Tank with working body
6. One-way valve
7. Electric valves
8. Micromotors

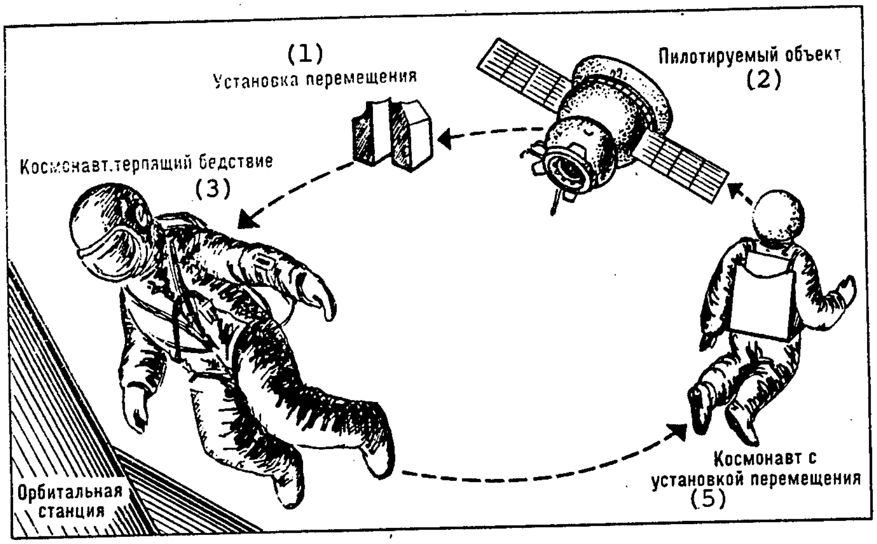
the motors designated as 4a in the figure on the preceding page, whereas for movement downward (+Z), motors 4b are turned on. In order to begin rotation relative to the center of mass it is necessary to turn on two motors that create a rotational moment. In particular, rotation around the +X axis is caused by left motor 4a and right motor 4b, and around the -X axis by left motor 4b and right motor 4a.

The choice of the combination of motors turned on during a maneuver is made by a logic unit; the cosmonaut sends it commands by means of a control knob (by moving it in the required direction from its middle or neutral position). This can also be done with an automatic unit. When compressed gas is used as the working body the system is simpler, since the fuel tank is eliminated from it and that tank's role is actually taken over by the tank containing the compressed gas.

ORIENTATION AND STABILIZATION SYSTEM

This system cannot operate without an instrument that measures the angular deflection of the cosmonaut and the pack from the required position in space and the rate of this deflection. A one-axis gyroscope is fully suitable for this purpose. A control knob is used for manual orientation. On the extravehicular movement pack there are two of them: one for controlling progressive motion, one for rotation around the center of mass. Both knobs are conveniently located on the elbow rests. By moving the knob through a certain angle, the cosmonaut sends a signal to the control system and maneuvers in space because of the production of linear or angular velocity. The extravehicular movement pack's operating time is directly dependent on the fuel supply. Therefore, it is very important that fuel (or gas) consumption be minimal during the maneuvering process. This is achieved in the following manner. The frequency with which the motors are turned on is selected as a function of the control signal's magnitude. For large control signals the motors are turned on more frequently (some maximum signal value causes continuous operation of the motors), whereas for small control signals they are turned on less frequently.

If the cosmonaut moves the control knob significantly, the motors will again operate for a long time and with short interruptions, after which the motor operating time decreases and the pauses between the discharges lengthen. When the angular rotation velocity indicated by the movement of the control knob is reached, the motors are turned off. If, after rotating through a certain angle, the cosmonaut wishes to stabilize his position, all he has to do is return the control knob to its original (neutral) position. The cosmonaut's rotation will then be perceived as a disturbance and the stabilization system will automatically begin to control the motors



System for rescuing a cosmonaut in open space. An emergency situation has arisen in the orbital station and a cosmonaut needs to return to Earth immediately. An automatically controlled extravehicular movement pack is sent from the emergency rescue ship. The cosmonaut straps it on and is returned to the ship.

Key:
1. Extravehicular movement pack
2. Manned craft
3. Cosmonaut in distress
4. Orbital station
5. Cosmonaut with extravehicular movement pack

so as to reduce the angular velocity of rotation to zero (in connection with this, an opposing pair of motors is turned on). However, let us assume that it is necessary to complete a progressive motion. The cosmonaut gives the command by moving the second control knob and the motors accelerate him to the desired velocity. When it is necessary to brake (when returning, for example, in order to make a "soft" contact with the ship), the cosmonaut turns an opposing pair of motors on and off, thereby reducing his rate of motion.

Progressive motion in space, where there are no reference points, can be controlled only with the help of a reactive force. In order to create the moments controlling rotational motion around a center of mass, it is possible to use either flywheel devices or power gyroscopes.

PROBLEMS AND PROSPECTS

Thus, to the reader it is now obvious that the orientation and stabilization system is one of the most complicated systems in a cosmonaut extravehicular movement pack. However, there is yet another factor that redoubles this complexity. As a matter of of fact, in this system the cosmonaut is not only the operator but, at the same time, is the controlled object. Thus, in a spacecraft, which is essentially a solid object, although a cosmonaut's mobility does play a certain role in the orientation and stabilization process, one would not call it the dominant role. Matters are otherwise in the system we are discussing. While working outside a ship, a

cosmonaut performs different motions with his arms and legs. These movements exert a disturbing effect on the entire stabilization system, thereby disrupting the cosmonaut's spatial orientation. In addition to this, such movements result in the constant displacement of the system's center of mass. The shifts in the center of mass are even more significant if the cosmonaut is carrying tools or any other load in his hands. If the progressive motion motors are turned on and the position of the center of mass does not coincide with the theoretical one, there immediately arise additional perturbing moments that affect the stabilization system.

Thus, on the one hand, a cosmonaut has to work, but on the other, his movements become disturbing ones for the stabilization system, disrupt his spatial orientation, and increase fuel consumption to counter all the new perturbations.

This is the problem that faces the designer who is working on the orientation and stabilization system.

Another problem is related to the fact that during maneuvering the cosmonaut has one or both hands occupied, which restricts the performance of any other type of operation.

In order to provide maneuverability and leave a cosmonaut's hands free, some specialists propose to introduce a voice control system. The cosmonaut pronounces a command word, such as "Forward." This word enters the logic unit, which identifies the human speech and immediately sends out electrical signals to the circuit that turns on the moment unit or the micromotors.

It is clear that extravehicular movement packs equipped with a voice control system give the additional capability of receiving commands from directly on board a spacecraft. The advantages of such packs are obvious. In the first place, the pack is able to function as an automatic robot. In the second, if a cosmonaut cannot control the pack himself, for any reason, the ship's crew can do it.

11746
CSO: 1866/102

UDC 517.11

ACCURACY OF SOLUTION OF KINEMATIC EQUATIONS: 2. USE OF QUASICOORDINATES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 20 Apr 81) pp 323-331

BRANETS, V. N.

[Abstract] After describing the classical method for the numerical solution of kinematic equations when the primary information is used as quasicoordinates, as applied to measurements of angular velocity by a singly integrating sensor that are then integrated and converted to a discrete form, the author examines the effect of instrument and noncommutability errors on measurement accuracy. He then applies his results to several examples, including the problems of the stabilization and rotation of a platformless inertial navigation system. Figures 7; references 7.
[113-11746]

UDC 621.031

SECULAR EVOLUTION OF ROTARY MOTION OF SATELLITE EQUIPPED WITH ELECTRIFIED SCREEN

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 3 Feb 81) pp 342-351

BELETSKIY, V. V. and KHENTOV, A. A.

[Abstract] The authors investigate the effect of the interaction of the charged particles of an electrified screen, used to shield an artificial Earth satellite against radiation, with the Earth's magnetic field on the satellite's motion relative to its center of mass. After formulating the problem and setting up the equation of motion for a dynamically symmetrical satellite, they examine the effect of secular effects on its rotation. They conclude that the interaction of a charged screen with the geomagnetic field results in the same secular effects (qualitatively speaking) on the satellite's

motion relative to its center of mass as the basic linear ones (magnetic, aerodynamic and rotation of the orbit's nodal line). Figures 8; references 5.
[113-11746]

UDC 629.197.2

ONE PROPERTY OF THREE-PULSE TRAJECTORIES THAT ARE OPTIMUM UNDER FLIGHT DISTANCE AND TIME LIMITATIONS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 31 Mar 81) pp 352-356

IVASHKIN, V. V., KOROVINA, L. A. and SKOROKHODOV, A. P.

[Abstract] The authors discuss three-burn trajectories that are optimum from the viewpoint of fuel consumption when changing from a lower to a higher orbit and where there are limitations on flight distance and time. Assuming three apsidal impulses, the authors prove two lemmas, which they then use to prove the theorem that for a trajectory that is optimum from the viewpoint of fuel consumption, the accelerating intermediate impulse should take place after the apocenter of the transitional orbit has been passed. Figures 2; references 6: 5 Russian, 1 Western.
[113-11746]

UDC 531.13:521.154

CONTROLLING DESCENT IN PERTURBED ATMOSPHERE ON BASIS OF VARIATIONAL METHOD OF SYNTHESIZING INVARIANT SYSTEMS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 30 Jun 81) pp 357-362

VELICHENKO, V. V. and KOZ'MINYKH, V. A.

[Abstract] Using the equation of motion of a controlled descending object, the authors apply the variational method for synthesizing invariant systems to obtain invariance of the control criterion functional with respect to perturbations and the terminal hypersurface. They then synthesize an equation insuring independence of the descent distance from perturbations, discuss the numerical calculations involved in realizing the descent control rule, and present a model of descent in the Earth's atmosphere that is invariant with respect to perturbations. Figures 5; references 4.
[113-11746]

UDC 531.38

MATHEMATICAL MODELS OF DOCKING DYNAMICS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82
(manuscript received 18 May 81) pp 363-375

SYROMYATNIKOV, V. S.

[Abstract] The author explains the basic principles of the construction of models for various types of spacecraft docking units, then develops models that allow for the specific nature of electromechanical docking devices. Assuming two solid bodies (the two spacecraft) and four systems of coordinates, he discusses a model of the docking process with a "pin-cone" mechanism, a model that allows for shock absorber deformations, a model of the processes that occur after capture, and a model for peripheral docking gear, as well as what takes place at the points of contact and the effects exerted by the two ships' control systems. The author also discusses the equations of motion and the process of shock absorption after capture, with due consideration for the shock absorption system's time lag. Figures 6; references 3.
[113-11746]

UDC 681.142.019.3

SIMPLE METHOD FOR IMPROVING CONVERGENCE OF NEWTON'S METHOD IN PROBLEM OF DETERMINING ORBITS OF LOW-FLYING ARTIFICIAL EARTH SATELLITES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82
(manuscript received 9 Apr 79) pp 472-474

DEGTYAREV, M. A.

[Abstract] When a seventh orbital element that characterizes an ISZ's [artificial Earth satellite] ballistic properties and the atmosphere's aerodynamic resistance is taken into consideration, the problem of determining the orbital parameters of low-flying ISZ's becomes quite complicated. If Newton's iterative method is used and the orbital parameters are represented in matrix form, the number of conditionality of the matrix must be quite small. The author presents two methods for scaling matrices that reduces this number by making the lengths of the lines and columns of the parameter matrix approximately identical. These methods can be realized on a computer, with the help of which the parameters of a low-flying ISZ can be determined quite accurately after three to five iterations. Figures 1; references 11.
[113-11746]

UDC 521.35

DETERMINING SPACECRAFT ORIENTATION FROM STAR IMAGES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 3 Sep 81) pp 481-484

AVANESOV, G. A., ZIMAN, Ya. L. and KRASIKOV, V. A.

[Abstract] The authors describe a method for the automated astrometric processing of stellar images that enables the orientation of both a spacecraft and the scientific equipment in it to be calculated. The complex of equipment used to do this consists of a scanning densitometer, a minicomputer, an external magnetic tape and magnetic disk memory, a display with a color monitor and a teletype. The technique is broken down into four basic stages (which are discussed in detail): element-by-element reading of the star images and entry of them in the computer; determination of the coordinates of the images of probable stars in the surveying camera's system of coordinates; star identification and rejection of false images; calculation of the orientation elements of the surveying camera, the spacecraft and other instruments installed in it. Figures 2; references 4.
[113-11746]

UDC 522.1:523.14

ABSOLUTE CALIBRATION OF SECONDARY ELECTRON MULTIPLIERS IN 400-1,200 Å BAND, USING SYNCHROTRON RADIATION FROM VEPP-2M ACCUMULATOR

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 20, No 3, May-Jun 82 (manuscript received 22 Jan 81) pp 485-488

GLUSKIN, Ye. S., KOCHUBEY, V. A. and NALIVAYKO, V. I.

[Abstract] The VEPP-2M accumulator belonging to the Institute of Nuclear Physics, Siberian Department, USSR Academy of Sciences, has been used for several years for the absolute calibration of vacuum ultraviolet radiation detectors in the 1,200-3,000 Å band, but its use for absolute calibration has now been extended to secondary electron multipliers of the VEU-6 type in the 400-1,200 Å band. The problem of eliminating or allowing for the high orders of diffraction was solved by using special holographic gratings. The authors describe the calibration process and present their results, which are of a preliminary nature since the calibration process is still being worked out. The estimated accuracy of the results is ±5 %. Figures 5; references 7: 6 Russian, 1 Western.
[113-11746]

SPACE METHODS IN OCEANOLOGY

Moscow KOSMICHESKIYE METODY V OKEANOLOGII (NOVOYE V ZHIZNI, NAUKE TEKHNIKE: SERIYA "KOSMONAVTIKA, ASTRONOMIYA") in Russian No 6, Jun 82 (signed to press 3 Jun 82) pp 2-4, 11-23, 64

[Annotation, table of contents, introduction and excerpt from booklet "Space Methods in Oceanology" by Anatoliy Aleksandrovich Bol'shakov in the "Astronautics and Astronomy" series of "What's New in Life, Science and Technology", Izdatel'stvo "Znaniye", 262,650 copies, 64 pages]

> [Excerpts] Investigating the earth from space from both specialized satellites and manned orbiting stations has been allocated an ever greater position in space programs in recent years. Among the broad complex of methods of space sounding of the earth, a large role is played by methods for studying the ocean. This is what this booklet is about.
>
> The booklet is intended for the broad range of readers interested in the applied aspects of astronautics.

CONTENTS

Introduction

Exploring the earth remotely from space by using satellites (ISZ) and manned orbiting space stations (OKS) has been assuming ever greater importance in domestic and foreign astronautics in recent years. Important "space" information on the make-up of our planet, its atmosphere, solid surface and water envelope has been obtained. This has been made possible by the diverse research equipment installed on Soviet and American satellites: Cosmos, Meteor, Nimbus, NOAA, Landsat and others; on the spaceships: Soyuz, Gemini and Apollo; and on the stations: Salyut and Skylab.

A considerable number of these space vehicles were intended for the needs of meteorology; on board many others, a rather general-purpose complex of research apparatus was installed to study earth's natural resources. And the very multi-planned information obtained by using these vehicles was used in part by meteorologists and in part by geologists, geographers, glaciologists and representatives of other earth sciences; only an insignificant part of the information has been used by oceanologists, the specialists in studying the ocean.

This fact, surprising at first glance, can be explained by oceanologists needing in the majority of cases very specific information that differs from that needed by specialists studying the atmosphere and solid envelope of earth. This circumstance as well as the ever increasing need for comprehensive, complex investigation of the ocean and navigational needs have been the stimuli for developing new methods of remote exploration and have resulted in the development by the USSR and the United States of specialized oceanologic satellites, i.e. designed just to study the ocean, at the end of the seventies.

Within the framework of the program for studying the ocean from space in the USSR, the Cosmos-1076 and Cosmos-1151 satellites were launched into orbits, as were the Intercosmos-20 and Intercosmos-21 oceanologic satellites developed in cooperation with specialists in the GDR, Hungarian People's Republic and the CSSR. In the United States, the Seasat satellite was launched into orbit under a program for studying the ocean. The term "space oceanology," now widespread and in general use, originated with the launches of these satellites.

The problems of space oceanology and the use of space methods and facilities for investigating and developing ocean resources are the topics considered in this booklet.

Studying the Ocean from Space in the Visible and Near Infrared Bands

In the visible and near infrared bands of the spectrum, the electromagnetic radiation of the ocean is the solar radiation reflected by the surface or scattered by the water mass of it. Ocean temperature does not exceed several tens of degrees Celsius; therefore, because of the action of known physical laws, there is essentially no ocean self-radiation in the bands in question.

Active optical methods of sufficient development have not yet been obtained; therefore, the ocean can be studied from space in the band of the spectrum only on the illuminated side of the earth (when, properly, studying solar radiation reflected by the ocean is possible too). The transmissivity of a clean cloudless atmosphere in this case is sufficiently high, and the interfering effect of the atmosphere during studies at the nadir or in the vicinity of this direction is small.

The simplest but one of the most informative methods of studying the ocean from space in the visible band of the spectrum which requires essentially no equipment is the method of visual observations from on board a spaceship or manned orbiting station. Results of studies in this case can be transferred to specially prepared plotting charts or simply drawn. In some cases, phenomena observed by astronauts can be photographed with cameras and thus rigorously documented.

The first visual observations of the ocean from space were the observations made by the astronauts in the first manned spaceships. After his historic flight, Yu. A. Gagarin said that the light blue color of the ocean does not appear invariable when observed from space. When looking at the ocean from orbit, one can easily see the regions that have a different tint, identify the shores and view the relief on the bottom in shallow waters. The space operating experience of many other Soviet and American astronauts indicates the high informativeness of visual observations of the ocean from space altitudes.

The technique of visual observations of the earth from space is simple and does not differ substantially from that of ordinary aerial views. The color hues of land, clouds and water areas are about the same as those seen when the earth is observed from an altitude of 10 km. The hues of various colors are easily discernable; however, test measurements of astronaut vision, made during the Soyuz-3 - Soyuz-5 flights and others, have shown that the contrast sensitivity of astronaut vision during the flight is reduced, as a rule, 10-20 percent. Under space flight conditions, the perception of brightness of colors, especially the red hues, also declines 20-25 percent compared to earth conditions.

The field of view of an astronaut when he is observing earth from space is determined by the dimensions of the spaceship porthole and the distance from the porthole to the astronaut's eyes. For instance, when porthole diameter is 30 cm and its distance to the eyes is also 30 cm, the astronaut's field of view while observing earth is 60°. When necessary, an astronaut can also vary the position of this field of view (to scan it) by moving himself relative to the porthole.

When the ocean is observed from space, especially well noticeable are the large changes in the color tone of the ocean in the oceanic frontal zones: areas where water masses having a different degree of saturation with coloring suspensions merge, at the bounds of major currents and in shallow waters. Thus, for example, the warm waters of the tropics are low in life and have a saturated blue-green color, while the cold waters of the temperate latitudes have a clearly expressed green hue caused by the high concentration of various microalgae, and therefore, the areas where these waters merge are clearly noticeable.

According to data supplied by V. Ryumin, the Salyut-6 flight engineer, visual observations of the ocean color are best when the sun is in a high position, when the color contrasts of ocean waters are especially noticeable. When the sun is low, the entire ocean appears a monotone, dark blue, but this is the best time to view surface phenomena, whirlpools, currents, and wakes of internal waves.

The list of phenomena and objects that can be observed from space by the eye is rather large. From the altitude of several hundred kilometers, one can confidently determine the bounds of the cones of turbid river waters flowing into the sea, view the relief of the bottom in shallow waters, determine the characteristics of mesoscale oceanic whirlpools, i.e. those having dimensions on the order of several hundred kilometers, discern even the type of plankton in bioproductive regions, detect the wakes of ships, etc.

When the ocean is observed from space, the studies are performed in a broad, continuously changing range of angles of view and conditions of illumination. In this

case, an astronaut's eye views a broad area of the ocean surface and objects picked out against the background of it are examined in more detail. Because of the high adaption characteristics of human vision, an astronaut is able to view and fix in memory many interesting details, even when they are observed for just a few seconds. The selective capability of human vision and logical analysis of given observations equip the astronaut-researcher with such capabilities of complex perception of observable phenomena that cannot now be achieved by any equipment.

The high value of visual observations of the ocean from space is determined by the perfection of the human eye as a metering tool, and by man's ability to instantly process perceived images, to separate the essential from the nonessential, to notice new features in familiar items, and to detect puzzling and unusual phenomena. Astronaut observation abilities increase sharply especially when they are well trained in advance; it is quite probable that astronauts-oceanologists will be members of crews on orbiting stations in the near future.

The effectiveness of visual observations of the ocean from space rises considerably when the flight is long and multiple observations are made of the same area. In this case, astronauts recognize familiar areas at once and detect changes that have occurred in them. This circumstance was noticed by many astronaut crews and especially by the main crews for the Salyut-6.

Sometimes in observing the ocean, astronauts have noticed phenomena and objects such that specialists on ocean optics were perplexed. Back during the flights on the early spaceships, it was observed that astronauts could well discern small-size objects against the background of the ocean, including even individual ships. For a long time, this seemed unreal. But then scientists analyzed this phenomenon and discovered that the adaption characteristics of human vision had been underestimated. It was found that under the conditions of space flight, astronaut vision acuity can improve noticeably.

Astronauts have reported several times that they distinctly saw in the ocean underwater oceanic ranges at depths of several hundred or even thousand meters. Specialists in optics maintain that this is impossible since even very transparent ocean water completely absorbs sunlight within just several hundred meters (thus, it is not possible to directly see the bottom of the ocean at greater depths). Analysis of this interesting data indicates that apparently in this case the astronauts are observing some other phenomenon associated in some way with the relief of the ocean bottom or simply similar to it.

Maybe this is how ocean surface relief irregularities appear when viewed from space; these irregularities are related to bottom relief, as has been discovered recently by using space altimeters. Or perhaps this phenomenon is related to the vertical movements of ocean waters following the underwater relief and making visible what is hidden when they come up to the surface. Also probable is that simply visible from orbit are variations in the spatial distribution of mineral and organic suspended matter which can be concentrated in an ocean layer of discontinuity of water density at depths of 30 to 100 m.

In summer at these depths, a layer of sharp deviation in water density develops and various ingredients may accumulate in it. When viewed from a high altitude (from

space), the spatial distribution of these suspensions that is random in nature may have a structure that is perceived as the image of some objects familiar to astronauts (in this case, mountain ranges they see during each orbit while passing over real mountains). But also possible is that this is simply a visual illusion just like the "canals" on Mars which were distinctly "seen" in telescopes by astronomers for a long time, but which did not exist in fact.

Science still has much to explain.

When the ocean surface is investigated at small viewing angles and near the bounds of a solar flash, astronauts sometimes observe ocean surface relief irregularities in the form of individual ridges and valleys. Thus, according to the data from the third main crew on the Salyut-6, V. Lyakhov and V. Ryumin, on one pass they saw in the Indian Ocean some kind of "raising up" of the water at 250 to 300 km from the African shore. The narrow strip of "raised" water was about 100 km long but only 1.5 to 2 km wide. They even saw a shadow, or something in this vein, from it on the water. The astronauts had the impression that two ridges had collided, as it were, in the ocean and were raised high up.

Just what this interesting phenomenon seen by astronauts is, oceanologists too cannot unequivocally explain yet. Maybe it is the appearance of internal ocean waves seen from orbit, or maybe it is the ocean surface relief irregularities mentioned earlier, but it is probably the result of the hydrodynamic interaction of ocean currents. In any case, these phenomena are of great interest to oceanologists and many more experiments will have to be conducted to be able to clearly understand them.

Very recently, the so-called visual-instrumental methods of studying the ocean from space have begun to be developed. These extend the capabilities of human vision. In the simplest case, binoculars and telescopes can be used, say, to investigate small-scale phenomena or objects. The capabilities of observing the ocean in low light and on the night side of orbit are being expanded considerably by employing night viewing devices with optical-electronic amplification of the light.

Astronauts can obtain precise colorimetric assessments of objects being investigated by using suitable instruments. In the simplest case, these may be ordinary seawater color tables or sets of containers with various shades of water (the Forel-Ul color scales widely known in classical oceanology). Optical-electronic colorimeters are well applicable for more precise measurements.

In general, visual investigation of the ocean from space is still going through a period of methodological formation, but it is already clear now that with suitable organization, it can provide much that is useful and interesting to oceanology.

One of the most proven ways of exploring earth's surface from space is space photography. Cameras, specially designed to operate in space, are installed on automatic satellites and manned stations; by now, hundreds of thousands of photographs have been taken of the earth's surface, including the ocean.

Even ordinary black-and-white, but more so color, photography may contain much oceanologic information. Much of what can be seen by astronaut eyes, except objects with very slight contrast, can be imprinted practically on space photography.

On the other hand, the information capabilities of modern photography in a number of cases are more extensive than those of human vision; and by using special types of photography, what cannot be seen with the naked eye can be recorded.

In obtaining information on the ocean in the form of photo images, the interpretability of particular oceanic objects is a function of their contrast (or relative brightness difference). Against some background, an object is visible only when its contrast is greater than some threshold value determined for specific conditions. This threshold value varies considerably for different observation systems. Thus, despite some loss in contrast sensitivity under the conditions of weightlessness, the human eye can discern objects having contrast on the order of 1 to 2 percent. Photographic and television systems in this respect, however, are far less sensitive; their threshold values of contrast are within the range of 10 to 20 percent.

This circumstance, by the way, is the reason why a number of oceanologic objects seen by astronauts and photographed in sessions of visual explorations of the ocean have not been interpreted in their photographs.

Existing space photographic systems have focal lengths of lenses on the order of several units or tens of centimeters. A photograph is made on film with a width of from 6 to 30 cm, which allows imprinting the ocean surface with an area up to several millions of square kilometers on one frame with good spatial resolution. The resolution of modern photographic systems is rather high, and oceanic objects with linear dimensions on the order of several meters are interpretable on photographs taken with them.

The relative brightness of objects in a broad band of wavelengths (400-800 nm) is measured, as it were, on isopanchromatic film in black-and-white photography. In this case, objects having identical integral brightness, but a different color, say, with a blue or red tint, are indistinguishable, which is well known to everyone familiar with the principles of photography. To emphasize the difference in spectral image representation of different natural formations, synchronous photography in two or three regions of the spectrum can be used.

For example, in photography in the spectral regions corresponding to the sensitivity of the visual receptors in the human eye--the blue, the green and the red--a color image of the object is obtained in natural colors. This principle and the three-layer light-sensitive photo materials are the basis for all conventional color photography, which is similar to tricolor human vision and approximately corresponds to it in its information characteristics. In recent years in making photographic surveys of the earth from space, new, more informative methods of surveying, primarily spectroregional and multiregional photography, have come into wide use.

In spectroregional photography, the principles of ordinary color photography are employed by using multilayer photo materials, but the spectral sensitivity of the layers is selected to that objects of interest to scientists show up better. To survey the ocean from space, one of the film layers can be made sensitive to rays in the near infrared region with wavelengths up to 1 μm. As a result, a number of interesting problems that are unapproachable for visual or conventional photographic methods can be solved.

These include primarily, for example, problems of detecting and surveying oil pollution in the ocean and assessing its bioproductivity. In the near infrared region, clean water completely absorbs the light incident on it, while polluted water, even slightly, reflects it. The content of algae and other suspensions in water has a similar effect on the reflection of water in this region. Therefore, spots of oil pollution in the ocean and its areas with a high content of contaminants show up on spectroregional photography (for example, on the SN-6 and SN-8 types of domestic film) in the form of characteristic pink spots.

Even greater capabilities of identifying fine spectral distinctions of various natural formations are typical of the methods of multispectral photography, based on taking synchronous photographs of natural objects in some narrow spectral intervals. The MKF-6 multispectral space camera, developed by specialists from the USSR and the GDR, is one of the most sophisticated cameras in this class. This camera allows surveying the earth's surface in six spectral regions at the same time.

In early experiments on surveying earth resources, regional light filters were used that had maximums of light transmission at these wavelengths: 480, 555, 600, 665, 730 and 840 nm. The width of each survey zone was rather small, not over 40 km. The curves of the spectral sensitivity for all the survey bands in the MKF-6 camera are shown in fig. 4. In surveying from an altitude of 250 km, each photograph takes in a 115 x 165 km area of the earth's surface with a ground resolution on the order of 10-20 m. Different types of photo materials are used in the MKF-6 camera, and a photometric wedge is imprinted on each frame when exposed to photometrically calibrate the materials.

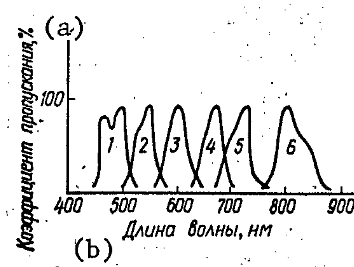


Fig. 4. Curves of spectral sensitivity of survey bands in MKF-6 camera

Key:
- a. transmission factor, %
- b. wavelength, nm

The first flight tests of the MKF-6 camera were made in 1976 during the Soyuz-22 flight under the Raduga experiment; this camera is now standard equipment on all Salyut orbiting stations.

Photo images of the ocean, obtained in the separate bands, are analyzed and interpreted by using the MSP-4 four-band projector to project enlarged combined images on a special screen. In doing so, the image on the MSP-4 screen can be displayed in real or arbitrary colors.

Using multiregional principles in photo surveys of the ocean allows recording rather fine variations in the color of the ocean surface and solving, in particular, the problem of studying the distribution of areas of enhanced bioproductivity in the ocean on the scale of the whole earth. Naturally, to solve these problems, multiregional space cameras must have high absolute (up to 15-20 percent) and relative (up to 3-5 percent) accuracy in photometric measurements, which is fully achieveable at the current state-of-the-art.

However, with all their advantages, photographic methods of surveying earth from space have a substantial shortcoming: The exposed film has to be sent to earth for processing. This affects especially methods of surveying the ocean, which must have high rapidity and periodicity in arrival of information because of the rapid changeability of the processes occurring in the ocean.

To solve the many problems of oceanology and, what is especially important, to predict particular phenomena in the ocean, oceanologists have to obtain information with no more than several hours delay and at a frequency up to several times per day. Naturally, in this case, photographic methods cannot help oceanologists, and this problem can be solved only by using television systems.

The first television images of the earth's surface were obtained from space back in the start of the sixties when the first meteorological satellites were launched. Although these images had low spatial (on the order of 1-2 km) and spectral (8-16 gradations of integral brightness in the 500-800 nm spectrum region) resolution, they allowed determining sectors of the ocean covered with ice, identifying shallow sectors, studying major ocean currents, etc.

Television systems with mechanical scanning of the beam have become most widespread in recent years. In this system (fig. 5), scanning an image of the earth's surface along the satellite flight path is performed through the movement of the satellite itself, and across, through rocking of a receiving television tube or special mirror.

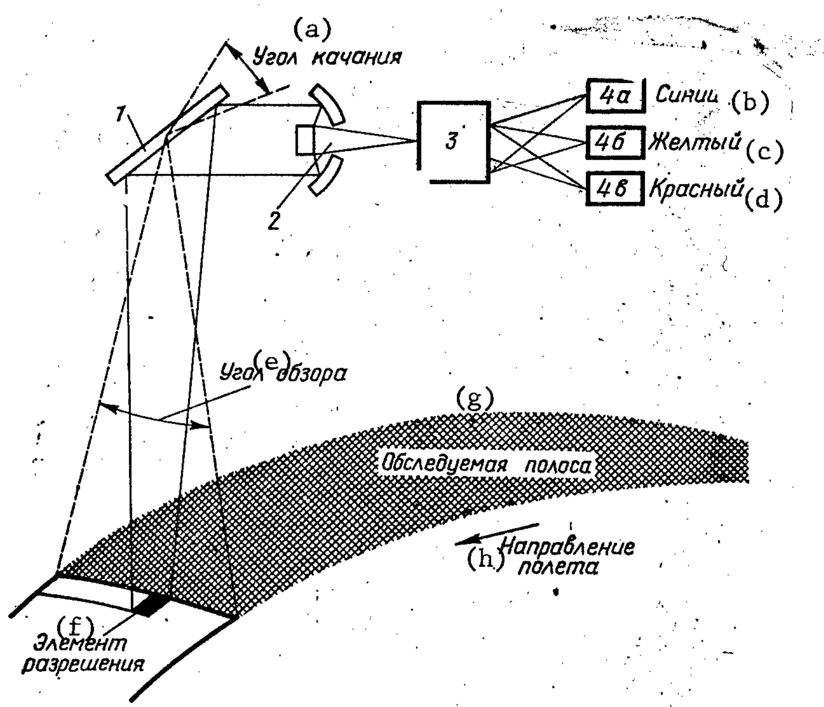


Fig. 5. Principle of operation of multiregional television scanning system:
1. rocking mirror
2. reflecting objective
3. light filters
4. radiation detectors

Key:
- a. rocking angle
- b. blue
- c. yellow
- d. red
- e. angle of view
- f. element of resolution
- g. surveyed path
- h. flight direction

In this television system, the spatial resolution is determined by the momentary field of view of the optical system, and the spectral, by the characteristics of the separation filters and sensitivity of the radiation detectors. The survey path width is a function of the satellite flight altitude and rocking angle of the pivoting mirror. Information from the television system can be transmitted to earth in real time or recorded by an on-board magnetic tape recorder for subsequent transmission at a suitable time when the satellite passes over a communication station.

Multichannel space scanning systems appeared at the start of the seventies; these systems have a spatial resolution better than 100 m and spectral resolution better than 100 nm. These instruments can now be used to obtain information comparable to that of photographic systems in their photometric and other characteristics.

Television images of the earth's surface sent, for example, by the Landsat satellite had a spatial resolution of about 70 m with a frame area of 185 x 185 km. The electromechanical scanning television system in this satellite made a synchronous survey of the earth's surface in four regions of the visible and near infrared bands of the spectrum (wavelength bands: 0.5-0.6, 0.6-0.7, 0.7-0.8 and 0.8-1.1 μm); after suitable computer processing, this system allowed obtaining images of the underlying surface in so-called arbitrary colors with good color gradation of various natural formations.

By using this system, a considerably greater range of oceanologic problems could now be solved. The data in specialized scientific literature indicated that some images sent by the Landsat satellite were used to determine ocean areas polluted by petroleum products and industrial discharges, to discover areas of enhanced bioproductivity that were previously unknown, to identify shallow sectors, areas where river and sea waters merged, to detect wakes of internal waves, etc.

It can also be noted that surveying in the short-wave band (0.5-0.6 μm), where absorption of light in ocean water is minimal, allows solving the problem of studying underwater relief and the bioproductivity of water the best way, while surveying in the long-wave bands (0.7-0.8 and 0.8-1.1 μm) allows identifying surface effects more clearly. Finally, combined processing of short and long wave data facilitates effective detection of ocean surface polluted by petroleum products.

The advantages of space television systems also include the capability of simple entry of information into a computer where it can be processed (by rather complex algorithms) to eliminate geometric, photometric and other distortions. When the video information is processed by computer, one can obtain final results in any cartographic projection by using the data of any number of spectral regions, which enhances considerably the informativeness of the data from remote sensing.

Using space photographic and television information has already enabled solving a number of interesting oceanologic problems. For example, one is the problem of detecting and studying the dynamics of internal waves mentioned earlier. These waves occur in the ocean at depths of several tens of meters where the density of deep layers of water changes. Internal waves determine the transmission of sound in the mass of ocean waters and the safety of submarine navigation. Many specialists believe internal waves were the cause of the loss of the "Thresher," an American nuclear submarine, several years ago.

Studying these waves by traditional contact methods requires a great deal of time and the use of many scientific research vessels. But they are sometimes directly visible on space photographs and some of their parameters can be measured. Internal waves develop in the depths of the ocean and are not observed directly on the surface, but a number of specific phenomena associated with them allow detecting them on space photographs. At least three typical types of interaction between internal waves and the surface layer of the ocean, which make them visible, can be cited.

Flucuating travels of water particles in internal waves may reach the ocean surface and, interacting with the current and wind, are capable of affecting the shape and distribution of ripples and small waves. In this case, alternating bands of ripples and smooth water will be observed on the ocean surface.

This picture on the ocean surface can sometimes be seen even with the naked eye when the ocean is observed from a high bank. The width of these bands may reach several hundreds of meters, and the length, many kilometers. Measurements taken by using scientific research vessels have shown that under the bands covered with ripples are the crests of internal waves, and under the smooth sections are the troughs. Bands of ripples and smooth water reflect solar rays in different ways, which also causes them to show up on space photographs.

The movement of water particles in internal waves when they reach the surface may be associated with the irregular distribution of surfactants affecting the shape of surface waves and reflection properties of the ocean surface.

In coastal regions, especially where the ocean surface layer is very turbid, internal waves can be detected on photographs because on the crests of the waves, the more transparent waters of the lower layer are lifted closer to the surface (on space photographs, these crests show up with a darker shade). The layer of turbid water is thicker in the troughs of internal waves and therefore looks brighter on photographs.

Appearances of internal waves are visible on many space photographs taken by crews on the Soyuz and Apollo spaceships and the Salyut and Skylab stations. These waves were detected, for example, near the coast of Columbia, Galapagos Islands, and Kamchatka, in the Arafura Sea and a number of other areas.

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MAJ GEN AVN FILIPCHENKO INTERVIEWED ON COSMONAUT RESOURCES

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 7, Jul 82 pp 44-45

[Article by I. Yudin: "Preparation of Cosmonauts in the Classroom, Air and Orbit"]

[Text] We are in the building of the student body of the Yu. A. Gagarin Center for Cosmonaut Training. Accompanying us is the twice-decorated Hero of the Soviet Union, Pilot-Cosmonaut of the USSR Major General of Aviation A. Filipchenko. We stop in front of a door with a plate, "Class of Space Natural History."

[Question] "Anatoliy Vasil'yevich, please tell us what this class is intended for."

[Answer] "The cosmonauts from orbit must be able to 'read' the surroundings, to quickly fix on what they have seen. To cultivate such skills, special exercises are conducted. On the television screen, placed in each work space, the surroundings which a cosmonaut might see from space are reproduced. In order to fix on what he has seen, he resorts to graphic means--writing, sketching. Or, he uses a tape recorder.

Our class is also equipped with an apparatus for the demonstration of receiving, and methods of interpreting, space photographs. On the screen you can simultaneously reproduce six photographs of one and the same place, taken with the camera MKF-6M in different ranges of the spectrum, superimposed one image on the other. Should you wish, they can be colored in various hues with filters. Then, for example, on the photograph fields of winter crops can be defined; where the shoots are good, sturdy, or where everything isn't all right with them. Various tints of color tell of this. In the same way, coniferous species of trees can be singled out in a mixed forest...

Besides the multi-zonal camera MKF-6M, which is now installed on the Soviet orbital station 'Salyut', a special projection device for processing space photographs was established in the GDR state enterprise 'Karl Zeiss Jena.' It enables, with a high degree of accuracy, the combining of images of separate frames into one; and, with the help of a set of changeable light filters, single out the necessary elements and details. It turns out that

this is a delicate and tedious affair. In order to hasten the process, they use an electronic computer which, according to spectral characteristics of objects, calculates the best combination of frames and light filters."

[Question] "When you look at photographs, maps, plans, presented in this class, hear of the effectiveness of space natural history, it is hard to believe that this all started from several frames, taken by German Stepanovich Titov during the flight on 'Vostok-2', from the first 'portrait' of Earth, obtained in 'full growth' by one of our 'Zonds', flying around the moon. Don't you have such sensations?"

[Answer] "Really, the effectiveness of studying the natural surroundings and the natural resources of Earth from space was a welcome surprise for all, and for the scientist, especially so. Academician Sidorenko said, when the first space craft were launched, that it seemed to many that space flights did not exert much influence on the natural sciences. But only a short time passed, and scientists realized what great significance space research has for geography, geodesy and cartography, geology, meteorology, agronomy, ecology, the study of water resources, the research of vegetation cover, and many others directed at scientific and economic activities of man. More than that, space research sometimes leads to the transformation of the natural sciences. And since they all have concern with practice, the everyday needs of people, then such transformations, in beneficial form, will influence the solution of national economic problems."

[Question] "How will future cosmonauts become familiar with the fundamentals of this direction in space research?"

[Answer] "Preparation in space natural history includes several stages. Starting here, in the Center, the future cosmonauts take a general theory courses--they listen to lectures on the principles of space natural history, learn about its problems, means and methods of probing Earth from space. Our specialists and collaborators from the State Center 'Priroda' give the lectures. Subsequently, specialists of the leading and key branch institutes of the ministries and departments familiarize the cosmonauts with the fundamental trends of research--of geology, oceanography, agriculture and forestry, soil sciences, hydrology, glaciology, environmental protection.

After that the cosmonauts undergo visual-observation training. Here, theory is reinforced with practice. Airborne laboratories fly on designated routes around several land and sea training grounds--parcels of land surfaces or water area, selected in a characteristic physical-geographic zone of the country. Annually, there are several such expeditions. The cosmonauts are accompanied by specialists in the area of research, which at that time is given preference. In the last expedition, for example, geologists participated. The route ran through the Caspian, Central Asia. The airborne laboratories are equipped with observation hatches, quartz, as on an orbital station, portholes, blisters. The cosmonauts bring maps, text books, photo apparatus, and binoculars with them.

During such training they learn how to find necessary objects from the air, they are shown direct and indirect signs, they are acquainted with means of surveying and observation, near to reality. And, although the altitude of the orbit of the station exceeds the altitude of the airborne laboratory many times over, the cosmonauts are of one opinion: such training gives the possibility to prepare well for work in orbit.

When the crew is formed, it trains in accordance with the program of the flight. At this time, the cosmonauts maintain close ties with the scientists and specialists of that scientific endavor, in the interest of which the work in space will be conducted."

[Question] "How does the necessity arise, of probing Earth from onboard an orbital space station with teh participation of man?"

[Answer] "To use surveying apparatus, to master the methods of its use most expediently on manned craft. The cosmonaut assembles and checks out the apparatus, studying its adjustment and control, selects the necessary conditions of work and the objects of research. He applies such methods of research, which best of all meet the conditions of the flight and the given problem. Automatic machines can't do this.

Man can quickly adapt to changing conditions, work simultaneously on several programs, select means of action, correct mistakes. He creatively resolves problems which arise, on the basis of logical analysis and experience gained during the study and preparation for the flight. And our cosmonauts more than once have demonstrated this."

[Question] "How much more effective will the international crews participating in natural history research be?"

[Answer] "Cosmonauts of socialistic countries were engaged in such research from the first. They underwent preparation for space natural history in Zvezdnyy Gorodok, learned methods of visual observation, the make-up of portable apparatus and stationary cameras MKF-6M and KATE-140, the spectrometer 'Spectr-15'.

The cosmonauts perfected methods and means of photography, ascertained the correctness of the transmission by photographic materials of the color of the earth's surface, worked out methods of visual recognition of objects and their composition, examined the water area of the seas and oceans, studied the large and high-concealed geological formations--circular dome-like and crater-like structures. They discovered and described polluted areas of surfaces of the land and the ocean, spontaneous phenomena--fires, floods, hurricanes. They regularly conducted mapping of forests and agricultural lands in the interests of forecasting their productivity on the territory of the country--participants of the 'Intercosmos' program, determined the characteristics of the hydrographic network.

As a result of the work conducted on 'Salyut-6', specialists of the socialist countries received thousands of photographs from space, notes in the light log, sketches, cassettes with spectrograms, and timely reports from onboard by radio.

Our friends acquired good practice and work experience in the field of space natural history. This helps them in the long-term research of the natural environment and the natural resources of their country."

[Question] "It is known that the processing of space photographs without automation is labor-consuming. What is being done to automate this process?"

[Answer] "At the initiative of the USSR State Committee for Science and Technology, several coordinating programs were developed regarding this problem. One of them envisions the creation of an interdepartmental center for processing space information. The experimental use of one of these centers has already begun, and the first results obtained. The modular program-control system KAMAK has been established for the processing of pictures. Corresponding member of the USSR Academy of Sciences Nesterikhin said that on its base, functional subsystems can be united in a single complex, including several electronic computers for various purposes, and 'technological' equipment--systems for input, output, storage, and for displaying optical information. For input of photographic representations to the computer, the precision system 'Zenit' is used, combining a high-speed 'readout' of the images (up to one hundred thousand photo elements per second) with a micron resolution for photography. During the readout, it's as if the images are divided into very small elements, or cells. The intensity of their luminescence manifests itself with numbers, which together with coordinates of definite elements of the images is written in the memory of the computer. The program control gives the possibility to 'call up' simultaneously, several pictures from the computer's memory.

The experimental center for processing information is equipped with a graph plotter-coder, electronic photo-plotter, a laser device for output of half-tint photographs. A holographic memory was also developed, allowing the storage of a large volume of information for an unlimited time.

In the Institute of Automation and Electrometry of the Siberian Department of the USSR Academy of Science, software was developed for the simultaneous analysis of six photographs, taken with the MKF-6M camera in various spectral intervals. A complex of systems was developed for the analysis of images where photographs, made in various bands of the spectrum, are combined. And then the electronic computer carries out classification and 'identification' of objects of the survey. In this way the condition of agricultural land and the degree of pollution of bodies of water can be determined and the conformity between images received from space and the results of surface measurements can be defined.

We can visualize tomorrow's space natural history. It is--systematic, complex research on natural processes and phenomena together with mathematical methods and automation for processing space information. And so that this information will be qualitative, timely and complete, much will, as previously, depend on the cosmonauts, their knowledge, skills and experience. All of this they acquire here, in the Yu. A. Gagarin Center for the Training of Cosmonauts.

12198
CSO: 1866/130

'SALYUT-6' AND COOPERATIVE EARTH RESOURCES STUDIES

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 2, Mar-Apr 82 pp 30-32

[Article by Aleksandr Koval', division director, State "Priroda" Center, and Yuriy Tyurin, CEMA Secretariat: "'Salyut-6'--a New Contribution by Socialist Countries to the Study of the National Environment"]

[Text] The achievements of socialist countries in exploration of outer space and use of space technology to solve scientific and practical problems are growing with every year. Space communication and weather systems have been created and are being used on a cooperative basis, and scientific satellites in the "Intercosmos," "Prognoz" and many other series are being launched carrying equipment developed and manufactured in the CEMA countries. But orbiting stations with interchangeable crews are man's main road into space. Thus the scientific station "Salyut-6" has been serving a cosmic watch in near-earth space for more than 4 years. During this time, five main expeditions and nine visiting expeditions completed their program successfully aboard it with the participation of cosmonauts from Czechoslovakia, Poland, the GDR, Bulgaria, Hungary, Vietnam, Cuba, Mongolia and Romania.

An extensive program of research and experimentation in space biology, medicine, physics and technology was completed during joint flights by international crews. But perhaps the largest program entailed a comprehensive study of our planet, its natural resources, atmosphere, the oceans and the biosphere. For this purpose the earth's surface was photographed from aboard "Salyut-6" with an MKF-6M multizonal camera and a KATE-140 topographic camera, the natural environment was observed with visual instruments, photographs were taken with various portable cameras through the station's portholes, and the underlying surface and the atmosphere were subjected to spectrophotometric analysis.

Further development of the earth sciences depends more today on the diverse information obtained from aboard spacecraft. Cosmonautics permits us to study global processes, to inspect the mutual relationships and interdependence of phenomena occurring in the lithosphere, oceanosphere, atmosphere and biosphere with a consideration for the physical factors of outer space and anthropogenic influences upon nature, and to systematically analyze the natural phenomenon of earth, descending from the general to the particular.

This is why crews representing the socialist countries and working together aboard "Salyut-6" devoted great attention to the problems of studying natural history from

outer space. These efforts were coordinated by a working group on remote study of the earth in the "Intercosmos" program. This group was created in April 1975 in compliance with a decision of the Conference of Directors of National Coordinating Organs of Countries Participating in the "Intercosmos" Program (Prague, 8-14 December 1974) and the Interim Statute on Permanent Working Groups on the Principal Directions of Cooperation of Socialist Countries in Exploration and Exploitation of Outer Space for Peaceful Purposes, dated 14 June 1968.

It was presumed that the program for investigation of the earth's natural resources (the IPRZ program) aboard "Salyut-6" would permit us to make effective use of survey materials gathered in outer space to solve the problems associated with development of the productive forces of the CEMA countries, with regard to the requirements of sensible use of natural resources and environmental protection.

Photographs of the territory of Czechoslovakia and Poland were obtained with an MKF-6M camera in 1978 during a flight aboard "Salyut-6" by Soviet-Czechoslovak and Soviet-Polish crews. These materials were submitted to experts of these countries for use for scientific and practical purposes. The accumulated experience made it possible to significantly expand the IPRZ program, and the third international expedition, in which an East German cosmonaut participated (August-September 1978), was able to perform two experiments. The first entailed observation of objects and phenomena on the earth's surface with visual instruments and their photography with hand-held cameras using different types of films, and the second entailed photography using permanently installed MKF-6M and KATE-140 cameras. These experiments were named "Biosphere" and "MKF-6M" respectively.

Later on, similar experiments were conducted by cosmonauts representing different countries: Bulgaria--"Biosphere-B" and "MKF-6M"; Hungary--"Biosphere-M" and "MKF-6M"; Vietnam--"Biosphere-V" and "Natural Resources"; Cuba--"Biosphere-K" and "Tropico-3"; Mongolia--"Biosphere-MOM" and "Eldem." The participants of some expeditions used the "Spektr-15" spectrometer, manufactured in Bulgaria. In these cases the experiments were given the following names depending on the country representated by the cosmonaut: Bulgaria--"Balkan," Hungary--"Pannoniya," Vietnam--"Kyulong," Cuba--"Antiyas" and Mongolia--"Solongo."

Members of the expeditions underwent special training in the techniques of studying natural history from outer space at the Cosmonaut Training Center imeni Yu. A. Gagarin (USSR). Scientists and practical workers of the national economies of countries participating in the "Intercosmos" program took an active part in the cosmonaut training.

The main objectives of the "Biosphere" experiments, in which cosmonaut-observers armed with binoculars, chromaticity atlases and portable cameras were given the main role, were: further improvement of the methods and resources of photography from outer space; selection of optimum angles for photographing specific natural objects in different states, and selection of photographic films, light filters and settings that would best reflect the real pattern of land and water; clarification of the degree to which photographs reproduce the chromaticity of the underlying surface; development and improvement of the methods of visual identification of objects and their state by cosmonaut-researchers in orbit; investigation of the optical properties of the atmosphere in different conditions of observation.

The observations and photography in the "Biosphere" program were intended to support investigation of interesting geological formations (lineaments, circular, dome-shaped and crater-like structures and so on) the basins of the World Ocean (currents, ocean fronts, zones of upwelling, eddy formation, regions of heightened biological productivity and so on), interesting and unique meteorological phenomena and regions of pollution of the atmosphere, the land surface and the ocean (domes of atmospheric contamination above large cities and industrial facilities, turbid river discharges, oil slicks on the ocean and so on) and natural phenomena (cyclones, dust and sand storms, fires, floods, volcanic eruptions and so on).

Photographs taken of socialist countries from outer space by permanently mounted cameras help to solve scientific and national economic problems associated with studying the geological structure and the structural arrangement of mineral zones, mapping agricultural land and predicting its productivity, determining the characteristics of the hydrographic network and predicting which regions would be inundated by floods, mapping forests and controlling damage to the forests, conducting morphostructural analyses of terrain and the continental shelf, and monitoring pollution of air and water basins.

Remote earth sensing using "Spektr-15" apparatus permits us to study the spectral reflective characteristics of different natural objects on the territory of countries participating in the experiment, and their variability in space and time; to work out the techniques of determining the atmosphere's optical transfer function and to analyze the optical characteristics of the atmosphere by measuring the angular structure of the earth's brightness field (the "Atmosphere" experiment); to measure the frequency characteristics of the atmosphere's transfer functions depending on its pollution above large industrial centers located on the coast, where natural contact exists between land and water (the "Contrast" experiment).

All of these experiments associated with the program for remote earth sensing were completed successfully, and scientists and specialists from the national economies of countries participating in the "Intercosmos" program received a diversity of information on the natural environment. The processing of this information is still going on today.

On the whole, the joint studies made with the direct participation of representatives of different countries aboard a permanent manned orbiting station promoted: access of all CEMA countries to spacecraft and to the technology and resources of developing the latest cosmic apparatus for remote earth sensing, and so on, making it possible for them to utilize the most progressive technical and scientific achievements in their national economies; inclusion of specialists from socialist countries in the process of imparting a cosmic foundation to the earth sciences; development of a new scientific-practical area--cosmic natural history; transformation of cooperation in the development of outer space into a new factor unifying fraternal peoples and strengthening friendship between them.

The experience of operating the "Salyut-6" Soviet orbiting station with the participation of socialist countries showed that experiments in research associated with natural resources in the environment go beyond the framework of purely scientific interests and permit us to successfully solve a number of national economic and applied problems common to all men. In particular, permanent services could be

created in outer space to maintain surveillance over natural and meteorological phenomena and processes, pollution of the national environment, the distribution of biological resources in the World Ocean and the hydrogeological situation. Regularly conducted long-term observations and periodic transmission of remote earth sensing data to processing centers provides a possibility for studying the dynamics of the oceanosphere, the landscapes and the surrounding environment, and for obtaining information to be used in creating the most diverse maps and, in the end, arriving at an integrated inventory of natural resources with the objective of achieving their sensible use.

The use of different remote earth sensing systems aboard "Salyut-6" (multizonal, topographical and portable cameras, spectrometers, binoculars) confirmed the suitability of conducting simultaneous research on the earth with instruments operating in different ranges of the electromagnetic spectrum. The unique possibilities afforded by orbiting manned stations allow us to include all of the remote earth sensing systems listed above into the measuring complex, while presence of man aboard guarantees their effective operation over a long period of time.

Our ideas about the way electromagnetic radiation interacts with various media are enjoying further development. Our knowledge of the spectral, polarizational, three-dimensional and structural features of terrestrial objects is deepening and getting more systematic. As a result we will be able to create catalogs of the types and states of natural objects on the basis of remotely measured data. This in turn will permit us to solve the reverse problems of remote sensing (that is, identifying natural objects). Automated processing of the obtained data will significantly raise the efficiency and reliability of their decoding.

In the opinion of Academician K. Grote, general secretary of the GDR Academy of Sciences and chairman of the "Intercosmos" Coordination Committee of the GDR Academy of Sciences, the results of research in space communication, space meteorology and remote earth sensing from outer space are the most important to practical use in the national economies of the CEMA countries. Achievements in these areas have become useful in geology, hydrology, agriculture, forestry and transportation. Scientists of the GDR have made their contribution to joint study of the problems of space, having created the MKF-6 camera and some other equipment. Space research is an important supplement to other methods of analyzing ecological problems, and thus it expands our information base for making decisions on sensible use of natural resources.

K. Serafimov, chairman of the National Committee for Exploration and Exploitation of Outer Space of the Bulgarian Academy of Sciences and a corresponding member of the Bulgarian Academy of Sciences, noted that the CEMA countries could make use of new methods of analyzing natural phenomena, technology, apparatus, technical resources and inventions developed in the course of space research in their national economies. Development of space communication, navigation, meteorology and other directions of the utilization of outer space has growing practical significance. The results of remote earth sensing are also being used more and more extensively in different areas of the national economy.

He believes that there are grounds for conducting joint applied projects, particularly by specialists of Bulgaria, the GDR and the USSR, in the processing of information from outer space. Moreover there are possibilities for cooperative

research with friendly developing countries--Ethiopia, Mozambique, Angola, Afghanistan etc.--mainly in the area of utilizing remote earth sensing data.

Academician L. Pal, chairman of the "Intercosmos" Council of the Hungarian Academy of Sciences emphasized how important it would be to organize, for the national economies of the CEMA countries, permanent services for space communication, meteorology and geodesics as well as remote sensing of the natural environment.

Development of outer space is stimulating development of the CEMA countries more and more. In turn, socialist economic integration is becoming more and more a material base for man's utilization of the achievements of space for peaceful purposes. "There are of course many secrets in outer space, and there is work out there enough for all," noted Comrade L. I. Brezhnev. "Therefore we favor the broadest interaction with other states in space research. Space can and must unite the inhabitants of the earth, and develop our understanding that people are living on the same planet and that it is up to them to keep this planet peaceful and flourishing."

11004
CSO: 1866/68

MULTIZONAL PHOTOGRAPHY SYSTEM PROPOSED FOR USSR STATE PRIZE

Moscow IZVESTIYA in Russian 30 Aug 82 p 2

[Article by Professor G. Shnyrev, deputy chief, Department of Science and Technology, USSR Gosplan: "Photography From Orbit"]

[Text] During the planning in the 11th Five-Year Plan of projects for the study and exploitation of various natural resources, allowances were made for the extensive utilization of materials obtained by photographing the Earth's surface from space, which materials make it possible to solve many national economic problems effectively.

The possibility of introducing these new and promising methods into practice is provided by a complex of scientific investigations, instrument developments and airborne experiments conducted by the USSR Academy of Sciences' Institute of Space Research in collaboration with a number of other organizations. This complex of work, under the title "Development and Introduction in the National Economy of Multizonal Photography Techniques and Equipment for the Investigation of the Earth's Natural Resources From Space," was carried out in the period from 1968 to 1981 and has now been entered in the competition for the USSR State Prize.

The multizonal photography technique, which is based on surveying the same sections in several spectral bands simultaneously, was developed for the purpose of the remote determination of the physical, chemical and biological characteristics of terrestrial formations.

On the basis of the results obtained from on board the first "Salyut" and "Soyuz-12," Soviet scientists, in collaboration with specialists from the GDR, developed a standard complex of equipment that includes the MKF-6 multizonal space camera and the MSP-4 multicamera synthesizing projector. The MKF-6 camera is an extremely complex unit in which many achievements of optics, precision mechanics, electronics and automation are realized. With its wide viewing angle, it produces images with a high degree of detail, geometrical similarity, and an accurate depiction of the spectral brightnesses of terrestrial formations. The MSP-4 projector makes it possible to combine, by an optical method, zonal photographs of the same section by transforming them into a synthesized color image that insures effective interpretation and utilization of materials obtained by multizonal photography.

Flight testing of the MKF-6 and the first experimental production multizonal surveys of different regions were conducted on the "Soyuz-22" spacecraft in 1976.

From 1977 to 1981, the MKF-6M camera, which was developed on the basis of the results of the tests, functioned flawlessy on the "Salyut-6" orbital station, and such a unit is now being used for surveying from the "Salyut-7" station. The total area of the Earth's surface that has been photographed by these units is about half a billion square kilometers. It would take 100 airplanes 40 years to do this.

The basic clients for the space photographs that were obtained were various ministries and departments in the Soviet Union and other socialist countries. Practically all the Soviet and international crews who worked in the "Salyut-6" and "Salyut-7" stations took part in the conduct of these surveys.

According to expert evaluations made by the "Priroda" State Center (a specialized organization that plans space photographic surveys and processes and disseminates the materials obtained), the economic effect from the introduction in the national economy of the results of the cartographic processing of space surveying materials obtained from 1978 to 1981 exceeded 56 million rubles in the Central Asia region alone, in addition to shortening the time required to create cartographic documentation by 75-80 percent.

This work and its authors unconditionally deserve to be awarded the USSR State Prize.

11746
CSO: 1866/11

UDC 528.22(26):629.78

PROCESSING SATELLITE NAVIGATIONAL INFORMATION FOR MARINE GEODESY

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 5, May 82 pp 37-42

FIRSOV, Yu. G. and YAROVOY, B. D.

[Abstract] In marine geodesy it is most advantageous to use Doppler satellite observations which are not dependent on meteorological conditions and time of day and which ensure a high level of automation and mobility of the apparatus used. Satellite navigational systems (SNS) provide the user with all data needed for computing the coordinates of an object. The coordinates of stations used in tracking navigational satellites are computed in a unified coordinate system: the center of the ellipsoid used coincides with the center of mass and the shorter semiaxis coincides with the earth's axis of rotation. Data from such tracking are used in creating models of the earth's gravity field which are used in predicting orbits. Various problems involved in this work are discussed. The method for determining coordinates in the "Transit" SNS (WGS-72 geodetic system) is examined. The integral Doppler method is now in wide use. It involves counting of the number of periods of the difference frequency N_i in a fixed time interval ΔT. The number of difference frequency periods makes possible a determination of the difference in distances to two successive known positions of a navigational satellite in orbit. The random and systematic errors characteristic of this method are discussed, as well as ways to compensate for these errors. Depending on the interval ΔT, during one satellite transit it is possible to obtain from 8 to 40 Doppler readings, making it necessary to use numerical methods for solving the problem. The best way to determine station coordinates is by adjustment in a system of rectangular space coordinates is by adjustment in a system of rectangular space coordinates. In order to obtain the coordinates of a fixed station with an accuracy 2-5 m it is necessary to use a series of determinations made under different geometrical conditions. Such an algorithm for processing SNS data is used in the tie-in of geodetic points situated on drill rigs at sea, bottom stations in the geodetic control network and on research buoys. In order to solve various problems in marine geodesy it is necessary to determine the coordinates of a moving station, such as an expeditionary ship, and this should be accomplished in a geocentric space polar coordinate system. The result of

solution of such problems in a geocentric space polar coordinate system will be dependent on the accuracy in computing the local geocentric radius vector, and in actuality, on the accuracy in determining the height of the geoid above the general terrestrial ellipsoid. Allowance must be made for the difference in the time when the Doppler measurements were made when determining the coordinates of the moving station. In general, the coordinates of a moving station can be determined with an accuracy between 40 and 100 m. However, the accuracy of modern means for determining coordinates is inadequate for solving most problems in marine geodesy at considerable distances from the shore and therefore it is necessary to make combined use of different data, including satellite data. The formulas presented in this article can be used in developing programs for the routine and final processing of SNS data for solving problems in marine geodesy. References: 6 Russian. [141-5303]

UDC 528.77:711.1(202):(551.324+556.5)

USING SPACE PHOTOGRAPHS IN MAPPING GLACIERS AND WATER BODIES

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 5, May 82 pp 24-30

ALIMUKHAMEDOV, M. A., LESNIK, Yu. N. and TIMOSHENKO, A. M.

[Abstract] Space methods are making it possible to collect important data on snow and ice conditions in high mountains and on water bodies. The authors illustrate this by presentation of data on the basin of the Fedchenko glacier, the Aydaro-Arnasayskiy water complex, the Sarykamyshskaya depression and the basins of the Chirchik and Angren Rivers. The materials used were black-and-white, multizonal, spectrozonal and color space photographs. A comparison was made of photographs obtained in the same spectral range but in different seasons of the year and at approximately the same season but in different spectral ranges. On all photographs it is easy to discriminate the seasonal snow boundary, as well as the firn boundary (a bright white phototone is replaced by a light gray tone). Moraines (except on color and spectrozonal photographs) in the zone 700-850 nm are expressed by two phototone gradiations (gray and dark gray). The degree of interpretability of major water bodies is the same on all space photographs, but the most informative were those taken in the spectral zone with a wavelength 600-700 nm. Small-scale photographs make possible a reliable interpretation only of such large streams as the Chirchik and Angren. Spectrozonal space photographs make it possible to trace the boundaries of moistening (these show up in a blue color). On black-and-white photographs the image of major water bodies is black, although there is some lightening of the photone along the margins. Small water bodies, such as lakes on glaciers, are also easily interpreted. Space photographs were used in mapping glaciation in the basin of Fedchenko glacier; the contours on this map virtually coincided with the contours on a topographic map of the same scale. The map made it possible to determine the principal morphometric characteristics of this glaciated area. Many

important details were revealed. Other photographs were interpreted to ascertain the volume of hydrographic data which can be obtained and studying the possibilities of obtaining various morphometric characteristics of lakes; the broad coverage of space photographs makes it possible to study the structure of a lake system as a whole and ascertain its interrelationship to other natural components. All this and more is illustrated in the case, for example, of Lake Sarykamysh, created during the last 15 years. The materials presented in the article reveal that the use of space photographs in the study of glaciological and hydrological features in Central Asia ensured routine monitoring of their state and dynamics. Figures 5; tables 3; references: 5 Russian.
[141-5303]

UDC 629.7:525

ARCHITECTONICS OF VEGETATIVE COVER USING REMOTE LASER SENSING

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA B: GEOLOGICHESKIYE, KHIMICHESKIYE I BIOLOGICHESKIYE NAUKI in Russian No 6, Jun 82 (manuscript received 26 Feb 82) pp 56-58

KANEVSKIY, V. A., ROSS, Yu. K., RYAZANTSEV, V. F., SHVAREVA, S. G. and SHELYAG-SOSONKO, Yu. R., corresponding member, UkSSR Academy of Sciences

[Abstract] Aircraft studies of the distribution of the intensity of solar radiation reflected from vegetative cover (the scattering indicatrix) provide information about the cover's geometric structure. However, the passive spectrometric methods used in such surveys cannot measure back scattering directly toward the sun because of the airplane's shadow. The authors outline an active method for making such measurements that utilizes a laser and two photoreceivers placed so as to receive the reflected laser radiation at angles of 0° and 2° to the direction of the laser beam. They present the results of a simulation experiment that was performed and suggest what equipment to use for an actual aerial survey. Such surveys would be best performed at night, when the "noise" caused by solar radiation is at a minimum. Figures 3; references 7.
[126-11746]

UDC 528.77:550.814+629.78(477)

SPACE TECTONIC MAP OF UKRAINIAN SHIELD

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 82 (manuscript received 30 Oct 81) pp 5-14

BELEVTSEV, Ya. N., BYSTREVSKAYA, S. S., SEMENYUK, N. P., ZEMSKOV, G. A. and ZYKOV, Ye. A., Institute of Geochemistry and Physics of Minerals, UkSSR Academy of Sciences, Kiev; "Kirovgeologiya" Geological Production Association

[Abstract] The great volume of processed space photographs for the territory of the Ukrainian shield enabled the authors to compile a space tectonic map of the Ukrainian shield at a scale of 1:1,000,000, reproduced in this article. The map was based on multizonal space photographs with different levels of generalization taken from Soviet and American satellites and spaceships. The map reveals the spatial distribution of the principal structural elements of the Precambrian basement manifested on space photographs at different scales. Only crustal elements interpreted from space photographs are plotted. The authors developed a method for geological-structural and structural-geomorphological interpretation of space photographs at different scales applicable to the landscape-geological conditions of the Ukrainian shield. The use of an optical-electronic system for the processing of multizonal space photographs made possible a maximum decrease in subjectivity in identifying geological features and facilitated perception of deep structural elements of the basement which are difficult to discriminate on black and white space photographs. An investigation indicated that all the major basement faults of transregional and regional ranks studied by geological-geophysical methods can also be detected on space photographs, but there is a considerable refinement of their spatial position, configuration, size, rank, time of last activation, predominant nature of movement in last stage of development; new, earlier unknown zones of dislocations were detected, those morphologically and geologically poorly manifested at the present-day surface and in the upper parts of the earth's crust. Tectonic dislocations of this type, almost not reflected in the modern relief and in the structure of the sedimentary cover, in some cases become the determining structures at deeper levels controlling endogenous mineralization and therefore requiring the quickest possible detection and study because of their economic importance. Figures 1; references: 15 Russian.
[6-5303]

UDC 551.25:629.78

METHOD FOR DETERMINING OPTIMUM AVERAGING AREA FOR GEOMETRICAL PARAMETERS OF LINEAMENT NETWORKS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 82 (manuscript received 29 Dec 81) pp 15-19

SHEREMET, O. G., MORALEV, V. M. and GONIKBERG, V. Ye., Lithosphere Institute, USSR Academy of Sciences, Moscow

[Abstract] The use of space photographs requires the development and introduction of standardized methods for extracting and analyzing the information incorporated in the photographs. Any space photograph contains so much information that it cannot be processes even with the most modern computer. The vast majority of this volume is excessive for any practical purposes. The extraction of significant information is a process of filtration of the initial mass of data and integration of the "primary" elementary signals. Accordingly, here the author proposes a heuristic method for determining the averaging interval whose size is close to optimum. The method described here is applicable in an automatic interpretation system for the read-out and compression of information for such purposes as the digital filtration of lineaments. The application of the described method is described for one of the principal criteria of structural interpretation--the total length of lineaments per unit area. The effectiveness of the method (involving calculation of minimum noise and minimum variations of the useful signal) is evaluated. It was possible to achieve a 25^x compression of the information exploitable from photographs, in effect involving elimination of signals not meaningful for the formulated purpose, thus achieving discrimination of geologically informative criteria. The described method for finding the optimum size of averaging grid is applicable in solving problems involved in predicting minerals and in seeking quantitative relationships among the geometrical parameters of the network of lineaments and the patterns of localization of any nonuniformly distributed geological features. Figures 3; references: 3 Russian.
[6-5303]

UDC 528.77:550.814+629.78

FEATURES OF STRUCTURE OF GREATER CAUCASUS DETECTED FROM SPACE PHOTOGRAPHS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 82 (manuscript received 13 Jul 81) pp 26-32

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[Abstract] The morphostructure of the Greater Caucasus, analyzed on the basis of space photographs, reveals a number of features which substantially

change concepts concerning its geological structure which have prevailed in the past. The first peculiarity is that the modern appearance of the morphostructure of the Greater Caucasus is governed by a system of deep faults and overthrusts reflected in relief of the Moho and which "show through" at the surface on space photographs. An analysis of space photographs indicated that the major lineaments limiting the structure of the Greater Caucasus for the most part coincide with deep faults defined on the basis of geological-geophysical data. However, the transverse lineaments do not determine the appearance of morphostructure of the Greater Caucasus because they cut across folded geological structures of different age and with respect to time of formation correspond to neotectonic and modern stresses in the earth's crust. The second feature is that in the morphostructure of the northern slope of the Greater Caucasus it is easy to see traces of an island arc with Lower- and Middle Paleozoic ophiolitic and island arc rock associations. The Greater Caucasus island arc archipelago developed as a boundary structure between Thetis, at whose site the Alpine geosynclinal belt developed, and a marginal sea separating it from the continental shelf of the East European platform. In the Greater Caucasus the crust is characterized by a considerable increase in thickness (up to 60 km) in comparison with the depressions surrounding it on the south and north, as in general is characteristic for island arcs. The third feature is that there is an isolation of the Eastern Caucasus from its remaining part. The fourth feature is that in the eastern part of the Greater Caucasus in a sector with a transverse rise there is an independent block structure constituting an ancient complex of the Paleozoic substrate. In general, the Greater Caucasus can be regarded as a model of the final stage in the development of island arc systems, the stage being reached by the Japanese-Kurile and Aleutian island arcs under the pressure of the subsiding Pacific Ocean plate. Figures 2; references: 18 Russian.
[6-5303]

UDC (528.94+551.24):(528.77+629.78)(477.6)

RESULTS OF STRUCTURAL MAPPING OF EASTERN DONBAS USING SPACE PHOTOGRAPHS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 82
(manuscript received 24 Sep 81) pp 45-52

POGREBNOV, N. N., All-Union Scientific Research Geological Prospecting Institute of Coal Deposits, Rostov-na-Donu

[Abstract] The space photostructural map of the Eastern Donbas published in this article (and described in detail) represents the first attempt at mapping the coal basin from space photographs. The map was compiled for the following purposes: 1) determination of interpretation criteria for the principal geological features in the basin; 2) comparative analysis of the detected structures with those known on the basis of geological-geophysical data; 3) development of a method for geological interpretation of results of interpretation of space photographs for the coal basin with the use of

geological and geophysical data; 4) development of a legend and method for compiling maps with the use of space photographs; 5) clarification of a series of problems in coal geology whose solution is now possible using space photographs. In compiling the map use was made of photographs taken from "Meteor" artificial earth satellites with an intermediate level of resolution and space photographs from the "Cosmos" satellites and "Salyut" spaceships at a scale of 1:1,000,000. The following are discussed in detail: dislocations; tectonic blocks; ring structures; plicative structures and boundaries of lithological complexes. As indicated by the materials presented here, space photographs have made it possible to detect structures of different ranks and an abundance of other information of economic importance to the coal industry. It has been possible to trace major faults, classified by scale, including those controlling the occurrence of coal-bearing formations; the region of development of the coal complex not covered by Mesozoic-Cenozoic deposits has been outlined; faults and folds in the coal-bearing strata have been mapped and many new, important structures, including those spatially coinciding with local uplifts and anomalies of recent movements, have been defined. Figures 2; references: 15 Russian.
[6-5303]

UDC 581.9:(528.77+629.78)(575.1)

USING MATERIALS FROM SPACE PHOTOSURVEY FOR STUDYING AND MAPPING VEGETATION COVER IN DESERT ZONE OF UZBEKISTAN

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 82 (manuscript received 20 Jul 81) pp 53-58

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[Abstract] The article describes the development and use of materials from a space photographic survey for studying and mapping the vegetation resources of Uzbekistan in the example of the extensive "Avangard" livestock sovkhoz, situated in the central part of the Kyzylkum. The mapping of vegetation with the use of space photoinformation involved the following procedures: preliminary office interpretation of space photographs, compilation of a preliminary map, surface and aerovisual correction of the detected vegetation groupings, final compilation of vegetation map and legend. The objective of the studies was the maximum extraction of the information contained in the space photographs. The so-called "landscape" method was used in the geobotanical interpretation of space photographs. The distinctive geobotanical units were outlined on the basis of direct interpretation criteria (phototone and image structure), whereas the interpretation of these units (associations) is on the basis of indirect criteria, primarily the association of vegetation with different landscape elements (relief forms, soil types, etc.). This made it possible to detect intralandscape relationships of plant associations and their place among other natural formations. In the analysis of enlarged desert photographs the dominant

criteria for the identification of vegetation are: form of sand deposits, composition of soil-forming rocks, moistening conditions, imagery of the vegetation itself. The mapping was done using black-and-white photographs taken from the "Salyut-4" and the "Salyut-6" in the visible spectral range. Interpretation was possible using images enlarged by 2^x-15^x. The reliability of the defined vegetation coenoses was checked and made more precise in the field in the course of surface and aerovisual observations. The availability of such maps makes possible a more objective characterization of the present status and spatial distribution of plant groupings on farms, a more effective planning of intrafarm measures and search for minerals and ground water. Figures 1; tables 1; references: 23 Russian.
[6-5303]

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CHECKING HYPOTHESIS OF DISTRIBUTION OF PROBABILITIES LAW FOR BRIGHTNESS OF HOMOGENEOUS NATURAL FEATURES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 82 (manuscript received 26 Oct 81) pp 59-65

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[Abstract] The proper determination of the distribution laws of brightness variations is quite important in obtaining a stable statistical distribution of the brightness spectra of natural features, such as clouds, snow or land. The proper choice of the form of distribution function corresponding to the experimental data and the accuracy in evaluating the parameters of the distribution laws must be checked by statistical tests. Due to the inadequacies of other tests, in order to check hypotheses on the distribution laws for spectral brightnesses of natural features the author has developed a new test of fit called the "Inna" test. Various properties of the test are examined. As an example the article describes the results of analysis of the laws of distribution of spectral brightnesses of natural features in the spectral region 2-5.5 μm. These data were obtained using an aircraft spectrometer with a spectral resolution of about 0.1 μm and a field of view 3° x 4°. The spectra were obtained during flights at altitudes up to 10 km over homogeneous underlying surfaces with angles of sighting from 13 to 80° from the vertical with various solar altitudes and azimuthal angles. In all cases it was found that a log-normal distribution can be considered an adequately good approximation for the distribution of spectral brightnesses of natural formations of each considered type. Although the log-normal approximation of the distribution law of spectral brightnesses for natural features was obtained using measurement data for altitudes up to 10 km, it can be expected that with measurements from satellites it will also be correct for the region of the atmospheric transparency windows since for these spectral intervals flight altitude exerts little influence on brightness variations in comparison with the influence of changes in the reflective

and emissive properties of the underlying surface, whereas the influence of the atmospheric layer lying above 10 km on the brightness of natural landscapes is not only insignificant, but changes little, and therefore exerts a weak influence on brightness variations and their distribution law. Figures 3; tables 1; references 20: 11 Russian, 9 Western. [6-5303]

MINISTRY OF DEFENSE COMMENTATOR WRITES ON AMERICAN EFFORTS TO ACHIEVE MILITARY DOMINANCE IN SPACE

Leningrad LENINGRADSKAYA PRAVDA in Russian 4 Aug 82 p 3

[Article by A. T. Timofeyev, colonel, USSR Ministry of Defense: "The Pentagon Bursts Into Space"]

[Text] An expert of the USSR Ministry of Defense, Colonel A. T. Timofeyev, comments of American plans for the militarization of space at the request of V. Morozov, APN military reviewer.

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A recent prediction in the American journal MOTHER JONES was truly prophetic. It was written there that "under the conditions of the military psychosis prevailing in the United States it would not at all be surprising if American 'space forces' soon make their appearance. Then on 1 September 1982 the Pentagon declared circumterrestrial space to be a potential 'theater of military operations.' Beginning on that day a special command will start to operate in the armed forces of the United States with the mission for preparing for war in space. L. Allen, Chief of Staff, USAF, on the occasion of creation of this command, stated: "Research and development in the field of space weaponry will soon enable us to carry out military operations in outer space." In this connection Brigadier General B. Randolph, who heads the Air Force section on the development of space systems, emphasized: "Now we will seriously undertake the use of those possibilities which space affords us."

Against this background there is a false and cynical ring to the hypocritical comments contained in the presidential directive on space dated 4 July 1982 with respect to adherence of the United States to 'peaceful goals' in the exploration and use of space. In actuality, not only the Pentagon, but also official Washington, intend and strive to use space as none other than some 'absolute position,' the mastery of which supposedly will open the way to dominance on earth. It is not by chance that the first steps taken in activity in the space field by the present administration in the United States was what Senator W. Proxmire frankly called 'the militarization of NASA.' It shook up the leadership of this administration and made it a true appendage of the Pentagon. James Beggs, vice president of 'General Dynamics,' a leading supplier of the US Department of Defense, was named NASA administrator. H. Mark, former Secretary of the Air Force, became a deputy to Beggs. On the

initiative of the White House the Pentagon expenditures on military-space research have increased sharply. As reported by the journal NEWSWEEK, in 1982 they will be 5.8 billion dollars. This sum did not include those approximately 3 billion dollars which have been allocated for the implementation of so-called secret programs providing for the development of new types of space weaponry.

The many billions being poured out multiply the strength and fantasy of the transoceanic strategists. Without limiting themselves to the use of existing supporting space systems (reconnaissance, communication, navigation, meteorological and topographic support, and others), they have considerably accelerated work on the creation of active means for conducting military operations in space and from space. Now at the center of their attention are a great many plans for filling space with the latest weapons of different kinds.

One of the most important militaristic programs to which the Pentagon is now giving its greatest attention is the development of laser weapons. Leading military-industrial concerns in the United States have been involved in its implementation. Up to 1990 on this program alone Washington is planning to expend 50-60 billion dollars.

Another direction in work in this field is the creation by the United States of a new antisatellite system on the basis of a small interception satellite ('ASAT' program), developed by the 'Vought' and 'Boeing' Companies. The work carried out within the framework of the 'ASAT' program is in the stage of completion. The US Secretary of Defense Weinberger, according to the NEW YORK TIMES, has ordered the Air Force over the course of five years to adopt an antisatellite system into its armament.

A special place in the military plans of the United States is occupied by space ships which can be used more than once. Specialists from the Pentagon are examining ways to use them for establishing space military bases, placement of mines in space for damaging enemy artificial earth satellites, creation of large systems for the antimissile defense of space bases. There are discussions of the possibilities of using these ships as carriers of different types of weapons. American strategists would also like to see the space 'shuttle' as a space policeman for "inspecting foreign satellites, changing their flight trajectories, and if desired, their return to earth in orbit in the cargo compartment of the ship.

The unrestrained striving of the Pentagon to militarize space is also indicated by such facts as have been published in the press as news of the hasty construction of a joint space center in Colorado from which the new US space command should control operations in space and also the construction at Vandenberg Air Force Base (California) of a military cosmodrome for ships of the 'shuttle' system.

Without delving into the details of other American 'space' projects, it must be stated that they are all in accord with the daring idea of attaining a decisive supremacy over the USSR, plans for creating 'first strike' weapons. Evidence of this is the already mentioned presidential directive on the

national space policy of the United States, abounding in imperialistic pretensions to a leading role of the United States in space, the unrestricted use of space in American interests, directly aiming the Pentagon to preparations for war in space. Evidently, in Washington they still cannot understand that scientific-technical development at the present time is proceeding on a parallel course and the achievement of the desired supremacy is a virtually insoluble problem. The Soviet Union has all the necessary prerequisites for remaining on a par in any arms race unleashed by the United States.

But does the Earth, already overburdened with weaponry, need a war in 'space orbits'? The Soviet Union already answered this question negatively long ago. True to its peace-loving policy, even at the dawn of the space era, in 1958, it introduced in the UN a proposal providing for the use of space exclusively for peaceful purposes. Over the course of all subsequent years the Soviet government has undeviatingly striven to see that space will become an arena of exclusively peaceful cooperation. 'Let the shoreless space ocean be pure and free of arms of any kind,' emphasizes Comrade L. I. Brezhnev. 'We, through joint efforts, wish to attain a great and humane goal -- exclusion of the militarization of space.' And much has been done in this direction. But the United States, in pursuit of the illusion of military supremacy, does not cease to be a defender of creation of newer and newer types of weapons, including space weapons.

The Pentagon is carrying out preparations for conducting military operations in space under the cover of a great deal of verbiage concerning a supposed American 'lag' behind the USSR in the military field. The propaganda is being disseminated that the United States, supposedly, is developing space weaponry programs only out of the fear that similar projects have been launched in the USSR. All this is a premeditated lie, a propagandistic myth about the 'Soviet military threat.' The fact of the matter is that the Soviet Union has undertaken the next peaceful step: it has proposed that an international agreement be concluded on the banning of weapons of any kind in space. The Soviet draft of this agreement, reflecting the intentions of our country to solve this problem seriously and in a businesslike way, is now in the UN Disarmament Committee. However, the recommendation of the 36th Session of the UN General Assembly 'to proceed to negotiations for the purpose of agreement on a text for such an agreement' -- as a result of the opposition of the United States and some of its NATO allies -- is not being carried out. Until now no practical work has been begun on this important problem. The reason for this is clear: the United States is not interested in having a finalized system of international agreements which would impose a barrier on the path to the militarization of space.

Such are the facts. They unmask the true intentions of the United States to extend the arms race into space and at the same time again and again call for vigilance.

5303
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TASS ON U.S. SPENDING FOR MILITARY SPACE PROGRAMS

Moscow IZVESTIYA in Russian 14 Dec 82 p 5

[TASS Report: "Dangerous Plans"]

[Text] The United States is speeding up preparations for war in space. According to a report from the U.S. television company CBS, the Pentagon will soon begin construction of a new space operations command center near Colorado Springs, Colorado. The CBS report further stated that the present command center located near the city of Cheyenne is in charge of the expanding military space program which includes the growing military capabilities of spacecraft of the "Shuttle" type as well as reconnaissance, navigation and other satellites. This center also monitors Russian space activity.

In the proposed budget for the 1983 fiscal year, 150 million dollars are allocated for research to create a space-based laser system. This is in addition to the 1.6 billion dollars already spent for this purpose by the U.S. since the beginning of the 1960's. Total appropriations for this program will reach 60 billion dollars by 1990. Under a contract with NASA, eight U.S. aerospace corporations are studying possibilities for developing long-term orbital stations for carrying out military tasks.

The "New York Times" notes the rapid growth of allocations for preparation for war in space. The paper reports that the Reagan administration intends to increase expenditures for military space programs at a level of 10 percent a year while average increases in the Pentagon budget will be 7 percent. In the 1982 fiscal year, resources allocated for these purposes amounted to 6.4 billion dollars.

CSO: 1866/54-P

SOVIET-FRENCH COOPERATIVE SPACE PROGRAMS

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, Jun 82 pp 42-43

[Article by V. Kozyrev: "Cooperation in Space"]

[Text] On 30 June 1966, in Moscow, the Ministries of Foreign Affairs of the USSR and France signed an agreement between the two governments on cooperation in the field of the study and conquest of space for peaceful purposes. The basic areas for joint work were defined in this document: the study of outer space, space meteorology and aeronomy, communication via artificial Earth satellites, the exchange of scientific information, apprentices and scientific delegations, the organization of conferences and symposia. According to the agreement, the cooperation could also be extended in other directions. It subsequently was, into the fields of space biology, medicine and the science of materials.

Thus, the research encompasses almost all areas of modern space science. The conduct of this research involves the use of automatic lunar and interplanetary stations, artificial Earth satellites, manned orbital stations and research rockets, as well as laboratory aircraft, drifting high-altitude balloons and such ground facilities as radiotelescopes, special cameras and other instruments. In 15 years more than 30 joint projects and programs have been carried out, with results that have appeared in more than 200 joint scientific publications.

One of the most significant events in this collaboration has been the Soviet-French expedition into a near-Earth orbit. After discussing with Soviet specialists the techniques for investigating candidates and the requirements for them, the French National Center for Space Research (CNES) announced that it would select candidates for a Soviet-French flight into space. Applications were received from 430 people. After a preliminary examination by CNES, there remained 196 candidates, including 26 women. In April 1980, a group of Soviet medical specialists from the USSR Ministry of Health's Institute of Medical and Biological Problems and Zvezdnyy Gorodok arrived in Paris. They were to take part in the final selection of the candidates. By this time there remained only five. The final choice fell on (Chretien) and (Baudry).

(Jean-Loup Chretien) was born in La Rochelle in 1938. In 1962 he was graduated from military air school, after which he served in the French Air Force. In 1970 he was graduated from the French school for test pilots. Chretien's family lives in northern France, in Brittany. He has four sons. Jean-Loup arrived in Zvezdnyy Gorodok alone. He loves music, and brought his own organ with him from France.

(Patrick Baudry) was born in Douala, Cameroon, in 1946, and lived in Africa with his parents for a long time. His permanent residence is now in the South of France, in Bordeaux. After finishing military air school in 1970, he began serving in the French Air Force. Later, he was graduated from test pilot school in England. Patrik is interested in running, skiing and sailing. He has his wife and 5-year-old daughter with him in Zvezdnyy Gorodok.

As is well known, two main stages can be distinguished in the training of cosmonauts: general space and spaceflight. In the first stage the French candidates studied a theoretical course: flight dynamics, astronomy and cartography, principles of space navigation, manned spacecraft control systems. The program included specialized flight training and flights in laboratory aircraft for the purpose of learning astronavigation methods and undergoing testing under conditions of short-term weightlessness. The medical-biological training included the principles of aviation and space medicine, study and training of the vestibular system and physical training.

After a 2-month summer vacation and summer work in France, on 6 September 1981 the French cosmonauts returned to Zvezdnyy Gorodok and began their final training for the flight.

During the second stage, the crew trains for the specific program of the upcoming flight, using complex and specialized spacecraft and orbital station simulators. The scientific program for the flight consists of experiments in the science of materials in space, as well as astrophysical and biological-medical experiments.

For instance, the "Arkad" program has already been in existence for 10 years. Its purpose is to study the transfer of energy from the Sun to the Earth and investigate the interrelationship between phenomena in the Earth's magnetosphere and ionosphere. Many joint projects have been carried out, devoted to studies of the Sun, the "solar wind," the Earth's magnetosphere and upper atmosphere in the polar regions, the nature of the polar auroras and the magnetic relationship between magnetically coupled points on the same force line but in different hemispheres.

The "Araks" project can serve as an example of the so-called control effect on processes in near-Earth space. From Kerguelen Island in the southern part of the Indian Ocean, French "Eridan" launch vehicles have twice lifted an electron accelerator and a large complex of Soviet and French on-board scientific equipment. At altitudes of 120-200 km, the injector emitted powerful beams of electrons, as a result of which there appeared processes that can be interpreted as an artificial polar aurora.

The 21 September 1981 launch of the "Oreol-3" artificial Earth satellite, which was based on a Soviet AUOS [automatic, general-purpose orbital station], continued the "Arkad" program. Four Soviet, four French and three joint Soviet-French experiments are being conducted. In addition to the traditional ones, there are also several special centers for the reception of the scientific information: three Soviet ones, in Noril'sk, Kirovsk and Tarusa, and five French ones, in Toulouse, Kourou (French Guiana) and Tromso (Norway), on Kerguelen Island (Indian Ocean) and in Adelie Land (Antarctica).

Three French satellites--"MAS-1" and "MAS-2" (small technological satellites) and "Sneg-3" have been placed in orbit with the help of Soviet launch vehicles. Their purpose is research in the fields of X-ray and gamma-ray astronomy.

In the field of space biology and medicine, Soviet and French scientists are collaborating in such areas as radiobiology, immunology and cell biology. The two countries agreed on the order and volume of the clinico-physiological research to be performed by the French cosmonauts.

As was previously the case, joint work in space meteorology and aeronomy is being done in three areas: satellite meteorology, meteorological rockets and aeronomy. Information received from the "Meteor-2" artificial Earth satellite is being processed and interpreted on a regular basis. Nine Soviet expeditions to Kerguelen Island were engaged in sounding the upper layers of the atmosphere with M-100B meteorological rockets. Laser soundings of the nocturnal atmosphere and rocket measurements of electrical fields have been carried out from Hayes Island.

The experimental project for the transmission of Soviet and French television programs via the "Statsionar" satellite and the (Plemër-Bodu) (France) and "Vladimir" (USSR) ground stations is running successfully. The audio portion is transmitted by Soviet equipment installed in the (Rene Bartelemi) Scientific Research Center in Paris. At a meeting of representatives of the communications administrations of the USSR and France that was held in Moscow in July 1981, it was agreed that it is advisable to investigate the possibility of organizing a satellite communication link between the two countries.

Scientists and specialists from the USSR and France are working in a spirit of ever broader international cooperation on the prospective "Venus-Halley" project. The subject here is the study, by direct methods, of the planet Venus and Halley's Comet with the help of Soviet spacecraft of the "Venera" type. In order to do this, a complex of Soviet-French scientific equipment will be delivered to the surface of Venus and a fly-past craft will be sent to meet Halley's Comet. The plan is for it to carry scientific equipment developed in the USSR, Bulgaria, Hungary, Poland, Czechoslovakia, France, Austria and the FRG.

The uniqueness of this study of Halley's Comet is obvious. Early in 1986 it will pass by the Sun, which it will then not do for another 75 years. Scientists think that comets are the most primitive bodies remaining in our Solar System. It is possible that only in them is preserved information about the physical and chemical processes that were characteristic of the birth of the Solar System.

Of course, in a short article it is impossible to give a comprehensive description of all the fields of bilateral Soviet-French collaboration in space research. We limited ourselves to only one area of this work: investigations of the physical properties of space. Even here, however, we see practical confirmation of the Soviet Union's consistent line on extensive and mutually profitable cooperation with all nations.

11746
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LAUNCH OF FIRST SATELLITE RECALLED

Moscow IZVESTIYA in Russian 4 Oct 82 p 2

[Article by M. Kavyzin, engineer, participant in designing of first satellite: "How the First Satellite Was Born"]

[Text] The International Geophysical Year began in June 1957, and only two countries--the Soviet Union and the United States--announced plans to launch artificial Earth satellites as part of its program. American specialists publicized extensively their plans for the creation of satellites under the promising title of "Vanguard." However, the first attempts proved to be unsuccessful, and only in February 1958, under another program, was the first American satellite--"Explorer-1"--launched. The "Vanguard-1" satellite, weighing 1.5 kg, was sent into Earth orbit in March 1958. The United States was behind.

Thanks to the strenuous efforts of Soviet scientists, engineers and workers for the creation of an intercontinental ballistic missile, it was possible to make parallel preparations for the launching of an artificial Earth satellite.

In the design office under the leadership of Chief Designer S.P. Korolev, one of the planning subunits analyzed and selected the planned parameters and systems for the satellite. This work was supervised by M.K. Tikhonravov.

In the spring of 1957 it was decided to make the first satellite one with a simple design that was, of course, reliable enough for the realization of the flight program.

About the design of what was to become the first artificial heavenly body, the only thing that was known was the limitation on the weight: no more than 100 kg. Everything else had to be created, and there were no analogs in technology.

The equipment on the satellite was not complicated. The two radio transmitters, which operated on frequencies of 20.005 and 40.002 MHz, had to report on the pressure and temperature inside the satellite as well as carry out their basic assignment of transmitting signals to Earth in the form of the "beep, beep, beep" temporal telegraphic signals that are well known to everyone.

The designers provided a weight of 83.6 kg, which meant that the injection of the satellite into orbit could be accomplished more confidently and reliably and that the orbital altitude and time of existence of the satellite could be increased.

The working plans were developed according to a rigid schedule and in a short period of time. The process of creating the satellite, without sacrificing quality and reliability, went forward in parallel stages.

When the assembly of the first engineering model was completed, we reported it to Chief Designer S.P. Korolev and prepared to meet with him. The plant director, the production chief, the chief process engineer and the designers met in the assembly section.

The chief designer required that everything, beginning with the situation in the area where the assembly took place and ending with the individual parts, be governed by the special conditions for the creation of the first artificial satellite, an object for the appearance of which the best minds of mankind had striven so long.

"What kind of welded seam is this, Comrade Chief Process Engineer?" asked S.P. Korolev. The attempt to say that the work had been done by one of the best welders was not understood. "We need automatic welding, and that alone. The seam must be even, smooth, strong and--the main thing--completely airtight," demanded the chief designer.

Particular attention was paid to the development of a special system for the separation of the satellite from the hull of the rocket's last stage. It was practically impossible to do the experimental work completely under flight conditions, since a whole series of factors that would be present during separation could not be simulated: the overload, the reaction to the burn and weightlessness. Nevertheless, by using special devices and equipment, we conducted docking and separation tests repeatedly. What was finally used was reliable.

After finishing our work at the plant and flying to Baykonur cosmodrome, we found that the working conditions there were much more rigorous than in the design office and at the plant.

The lifting of a huge rocket from its assembly frame--particularly the first time--produces an impression in a man that cannot be compared with anything. There is a feeling of astonishment at the scale of the event, pride in human labor and concern about the outcome of the launch.

At the hour of readiness, when the rocket was fueled, Chief Designer S.P. Korolev sent me and two more specialists to the uppermost platform to take one more careful look at everything and close the hatch. From the height of the platform the overall view of the entire complex preparing for the launch was particularly impressive. We carried out our instructions with great diligence, reported to the launch command leader over the telephone and descended. In reporting to the chief designer, I was again assured that S.P. Korolev was also interested in those details about which one would think he could not know.

The launch took place at the appointed time.

What an amazing sight!

The satellite then separated from the rocket and the radio transmitter was turned on. But what else was taking place up there? We had to wait an hour and a half.

And when the gathered designers and analysts in the mobile radio station, with its sensitive equipment carried in a special motor vehicle, heard the satellite's signal from distant space, the well known "beep, beep, beep," the silence was broken with tempestuous delight and everyone embraced and kissed, congratulating each other.

11746
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REMINISCENCES ON BEGINNINGS OF SOVIET SPACE PROGRAM

Moscow PRAVDA in Russian 3 Oct 82 p 6

[Article by V. Gubarev: "Ascension to a Satellite"]

[Text] Prominent Soviet scientists had gathered in M.V. Keldysh's study. For the time being a few of them could only guess at the subject to be discussed. The first to step forward was Mikhail Klavdiyevich Tikhonravov.

"We are faced with solving a few problems that science has not yet encountered," he began. "And although Tsiolkovskiy, followed by experiments in the '30's--interrupted by the war--pointed out the paths to their solution to a certain extent, much is still unclear..."

"Satellite." This word was heard for the first time only very recently. It made no special impression, but was perceived as if the conversation merely concerned a new scientific instrument. Mikhail Klavdiyevich began to talk about basic design ideas, about the "stuffing" for this device, about the units needed for normal operation of a satellite, about how the scientific equipment placed in it should be "spliced" to the telemetry system and so on. However, from the reactions of several listeners Tikhonravov knew that the term "telemetry" needed to be clarified, so he patiently and in detail explained how information would pass from a satellite to Earth and be interpreted. He said that a powerful launch vehicle capable of injecting various spacecraft into near-Earth orbits was being built, and that many industrial enterprises were participating in the creation of space technology.

As usually happened with him, Mikhail Klavdiyevich got carried away, and his message began to resemble less a scientific report than a fascinating story, or at least it seemed that way to many of those present. This was also very interesting, since Tikhonravov knew how to speak graphically and atypically.

"I know how exciting a rocket launch is, and I am firmly convinced that if you see one even once, you will never forget it and will dream about another one," he said, and those present, although many of them had seen a rocket only in the pictures in Tsiolkovskiy's books, agreed that a rocket launch is actually a beautiful sight.

All the same, Korolev knew how to gather interesting people around himself! And, naturally, Mikhail Klavdiyevich was one of them. As long ago as the end of the 1940's Tikhonravov had suggested a number of interesting projects, including the idea of a man flying in a stratosphere rocket. Sergey Pavlovich instructed his department to draw up plans for a satellite.

Abram Fedorovich Ioffe entered the study. He had come from Leningrad for this meeting. As always, there was a gentle smile on his face that immediately won people over. Ioffe sat down and began listening to the speaker attentively.

The subject was the cooling units and power sources that had to be installed on board a satellite.

"Cooling units are too cumbersome for such objects," Ioffe injected into the conversation. He spoke quietly, as if thinking aloud. "And solar batteries--that's an interesting subject. We should probably get in touch with specialists from the Semiconductor Institute in Leningrad and Viktor Sergeyevich Vavilov's group at FIAN [Physics Institute imeni P.N. Lebedev, USSR Academy of Sciences]."

Keldysh immediately dialed the number of USSR Academy of Sciences Corresponding Member (now Academician) B.M. Vul.

"Bentsion Moiseyevich, we are encountering a few difficulties. It's necessary to maintain the thermal conditions of, for example, the Moon, only on a smaller scale. Is this possible with those instruments that Vavilov is concerned with?"

"Let's get in touch with the physicists who are dealing with this. The idea is actually very interesting and promising," Vul answered.

A short digression here. The associates at FIAN put a great deal of effort into creating the first solar batteries for Earth satellites. In order to do this they had to combine the efforts of several institutes, enlist the aid of industry and obtain pure silicon.

Solar batteries were installed on the third artificial Earth satellite; the work on them began with the telephone conversation between Keldysh and Vul.

The meeting continued. No shorthand record was made of it. At this time Mstislav Vsevolodivich did not expect any specific solutions and suggestions from his colleagues at the academy (although they did present some); his job was to determine the scale of the future program for the conquest of space and the main areas for investigation.

Those who were present at the meeting recall that the ideas for many experiments were born at the meeting and after a few years were realized on Earth satellites. Some of the scientists invited by M.V. Keldysh changed their areas of specialization and to this day are devoted to cosmonautics, although until that meeting they had not intended to couple their destiny to it.

Mstislav Vsevolodovich spoke at the end of the meeting.

"I will not review the results," he said. "I will not be mistaken if I say that we have arrived at the general conclusion that in the development of research with Earth satellites very many institutes can make a contribution, so our job is to interest them, as well as individual scientists, in our programs. I also hope for the assistance of many of those present here."

After the meeting Keldysh detained his associates for a moment.

"Tomorrow morning we have to send a letter to the academicians and the corresponding members, because we need their suggestions. Invite everyone who's needed for the creation of a magnetometer and an instrument for studying cosmic rays. On the whole, dear comrades, we must work on this without resting," Mstislav Vsevolodovich concluded with a smile.

One of his associates asked interestedly, "And for how long?"

"For the first stage, a year and a half or two," Keldysh answered, no longer smiling. "And then...I don't know...it's too big a project we're beginning, and right now it's even difficult to foresee its consequences."

That same evening Keldysh and Korolev met at the academy in order to outline the working plan for the next several months. They agreed that in the fall they might be able to approach the party's Central Committee and the government with concrete proposals for the creation of the scientific equipment for Earth satellites. This document would have to contain the names of the organizations and scientists who would develop the required instruments.

Yet another digression. Fifteen years later, when S.P. Korolev was no longer with us, I asked M.V. Keldysh to tell about those events in the summer of 1955, when the scientific program for the investigation of space began to take form. "The work went normally," answered the academician, "and...well...its fruits are well known." Keldysh did not like to talk about himself. Only sometimes, at a cosmodrome or at the Center for Long-Range Space Communication, when he had a few free hours, did he reminisce about the past. One day I was fortunate enough to hear his story of the "prolog to the satellite," as he himself put it. One phrase I will remember for the rest of my life. "This was a beautiful time, because we were young and even space didn't awe us," said Mstislav Vsevolodovich.

For many of those who were responsible for the launching of the first satellite on 4 October, its launch actually began in 1955. A powerful launch vehicle was created in S.V. Korolev's design office, the site for the construction of the cosmodrome had already been selected in Kazakhstan, and specialists from different institutes were being invited to the USSR Academy of Sciences. Working meetings were already being held.

The creation of a single instrument required the combined efforts of scientific research institutes, design offices, enterprises and laboratories. Many of them who were to work together for the next 25 years became acquainted with each other for the first time within the walls of the academy.

Very many of the scientists to whom M.V. Keldysh turned proposed various experiments. Even in the letters where no specific suggestions were made, the authors without fail emphasized that if there is a possibility of launching a satellite into space, it must be done. "As a rule, penetration into new areas leads to the discovery of those most important natural phenomena that extend the path of the development of human culture most significantly," wrote Academician P.L. Kapitsa.

In November, the USSR Academy of Sciences sent a letter explaining a clearcut program of scientific research in space to the CPSU Central Committee and the USSR Council of Ministers. The "Committee for Project 'D'" was formed in January 1956.

Its chairman was M.V. Keldysh. His deputies were S.P. Korolev and M.K. Tikhonravov and the scientific secretary was G.A. Skuridin.

Project "D" was a heavy artificial Earth satellite. This project was fully realized by the launch of the third Earth satellite on 15 May 1958.

And so, many venerable scientists began to learn. Academicians listen attentively to what Korolev's envoys told them. Engineers from his design office gave lectures on rocket technology, the design and configuration of the satellite, the installation of various systems. They, themselves, then became listeners, because the scientists now told them how best to study cosmic rays and magnetic fields, the upper atmosphere and the Sun. Then everyone bent over the drawings and "married" science and technology.

"Space University" functioned for a long time, and essentially it is still in operation today, since those principles of interaction that were worked out during the development of the first satellite proved to be effective. Any new project, including an international one, now begins with that same "marriage" of scientific problems and spacecraft systems. This is now the foundation of planning, but in those years it was just being created.

It was perhaps just at that time that a trait of S.P. Korolev that amazed many people reappeared. One wonders why the chief designer would be interested in scientific instruments, since his assignment was to build the rocket and the satellite itself. However, "S.P.," as Korolev was called in the design office, could not do otherwise, since he was interested in literally everything. He considered himself responsible for the experiment as a whole and for the entire program of work to be done in space. He did not want--indeed, did not know how--to divide matters into "his" and "other people's," although his own concerns were really enough for him. However, there was encouragement, which he felt at all times.

"The very idea and possibility of beginning research in space," recalls one of Keldysh's and Korolev's comrades, "seized people so greatly that they all worked selflessly. More than anything they were afraid that, for example, Sergey Pavlovich would say: 'On Saturady or Sunday you can rest.' This meant that he no longer needed you. And thus a joke was born. Upon his arrival at the design office, a young engineer asks the chief of the personnel department: 'Tell me, when does your working day begin and end?' The answer is, 'We work from hymn to hymn.' I read in someone's memoirs the following words: 'We were captives of our duty.' In my opinion, that was right. This was our duty to the party, the people, and our Fatherland."

Since the launching of the first--Soviet!--Earth satellite, 25 years have passed. We are rightfully proud of our achievements in space. And we always remember with gratitude those stood at the sources of the Soviet people's exploit in space. Their labor is reflected to today's feats.

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LAUNCH TABLE

LIST OF RECENT SOVIET SPACE LAUNCHES

Moscow TASS in English or Russian various dates

[Summary]

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
18 Nov 82	Cosmos-1421	286 km	216 km	89.2 min	70.4°
26 Nov 82	Raduga	36,640 km	--	24 hrs 40 min	1.3°
		(near-stationary circular orbit; communications satellite for continuous relay of telephone, telegraph and TV signals in centimeter band)			
3 Dec 82	Cosmos-1422	314 km	208 km	89 min	73°
8 Dec 82	Cosmos-1423	575 km	401 km	94.3 min	62.8°
15 Dec 82	Meteor-2	904 km	836 km	102 min	81.3°
		(Carries equipment for obtaining global pictures of cloud cover and underlying surface in visible and IR ranges in both direct transmission and storage modes; also has radiometry apparatus; data is received at State Center for Study of Natural Resrouces and USSR Hydromet Center)			
16 Dec 82	Cosmos-1424	371 km	179.4 km	89.7 min	64.9°
23 Dec 82	Cosmos-1425	374 km	237 km	90.3 min	70°
28 Dec 82	Cosmos-1426	377 km	209 km	90 min	50.6°
29 Dec 82	Cosmos-1427	494 km	464 km	94 min	65.8°

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